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**MOLLUSCA OF THE SOUTHWESTERN STATES—IX, THE SANTA CATALINA, RINCON, TORTILLITA AND GALIURA MOUNTAINS. X, THE MOUNTAINS OF THE GILA HEADWATERS.**

BY HENRY A. PILSBRY AND JAS. H. FERRISS.<sup>1</sup>

The Santa Catalina, in Pima County, north of Tucson, is one of the large ranges of Southern Arizona, about forty-five miles in length, including its Tanque Verde and Rincon outliers, with an extreme width of twenty-five miles. Mount Lemon with an elevation of 9,150 feet is heavily forested with yellow pine, quaking asp, cork bark fir (*Abies arizonica*), Douglas spruce (*Pseudotsuga mucronata*), cypress (*Cupressus arizonica*), other coniferous trees, large oaks and an alder as tall as a pine. The male fern and the brake stand here four feet in height. The Douglas spruce are eight feet in diameter. There is a forest gloom at mid-day, and a ground covering indicating a timber growth of many years without interruption by fires or lumbering. Winter often brings ten feet of snow. With numerous trout streams, it has the attractions, summer and winter, of the deep forests along the Canadian border without their annoying insects.

In quantity and number of species of the smaller snails the north slope of Mount Lemon has the best record so far. The odor-shooting, rough-coated Sonorella also is here in large numbers under the fallen bark of the Douglas spruce and the dead poles of the quaking asp and cork bark fir. Unlike his brethren with a polished coat, this snail seeks food and cover similar to those used by the Polygyras of timbered areas in the Mississippi valley and eastward.

The humid forest conditions of the region around Lemon Mountain prevail at Soldier Camp, Kellogg's Peak, Alder Canyon, Alder Springs. The Spud Rock Ranger Station and other high peaks of the Rincon section, except in lacking cork bark fir, also follow Mount Lemon closely in forest conditions. They have the large oaks and conifers, the quaking asp, and the heavy floor of humus underfoot, but not quite as many snails.

In the valleys of Bear Wallow and Sabino creeks, at the heart of the Santa Catalinas, the Arizonians of lower and hotter levels have

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<sup>1</sup> The field work covered by this report was by Ferriss, assisted in the Blue River region and the Mogollon Mountains by the late L. E. Daniels.

built villages of summer cottages. It is about a full day's journey from Tucson on horseback. A small saw mill furnishes building material for this summer society, for a sanitarium now under construction and for the copper mines over the ridge at the foot of Marble Peak.

Except in the valley of the San Pedro river and the village of Oracle only a few miners, ranch men and forest rangers are to be found in all this group of ranges. There are more bears and mountain lions than people.

The southern slopes of the Catalinas, the foot hills and mesas, and the Galiuro and Tortillita ranges are not heavily forested. At best it is low, open woods or desert shrubbery, through which the granite rocks and precipices glisten in the sun. The soil is dry, though often covered with fallen leaves and growing vegetation. A few Sonorellas and some of the smaller snails may be found at all altitudes in the rock slides, the talus, on all sides of the mountain, and in any kind of rock, especially smooth and stratified rock; sometimes also under fallen timber, or in small piles of boulders.

In the dry season, among dry and hot rocks, dead shells will be the rule. Here one must dig a full eight hour day for a live one. We find a two-foot bar of half inch octagonal steel very helpful. The bar should have a two-inch chisel edge flattened out at each end, one of these turned at a right angle like a hoe. It will weigh one and three-quarter pounds; a good digger, a jimmy for rock work, and a helpful staff in steep and rough places.

*Sonorella* is something of a rambler, more so than *Ashmunella* or *Oreohelix*, and upon damp days scouts may be met out in the fallen leaves far from their rocky homes. Often single, dead, lie along the trails where there is no shelter in the vicinity for snail kind. In 1913, on the south side of the Santa Catalinas in the dry season, day after day but one or two living Sonorellas were found. It was the same about Brush Corral Ranger Station, on the north side, in the rocky slides of the canyons nearly on a level with the river. In one of these slides of three or more feet in depth, three hundred good "bones" were found but none alive. It was also the same kind of collecting in the Galiuros and the Tortillitas in the winter of 1917-18.

A small deep slide of "porphyry" or shale, shaded partially with rose bushes, elder or gooseberry bushes, makes an ideal home for the Southwestern snails.

The Galiuro range, in Graham County, and the Tortillita range, in Pinal County, as yet unsurveyed, seem to have an elevation of

about 7,000 or 8,000 feet, granite or other igneous rock prevailing, and with but a little timber. A few ledges of sharp-pointed limestone, dolomite probably, had no attraction for the snails. The entire region at present is inaccessible except to horsemen and pedestrians and these should carry their own food and shelter. We did, and lived like kings before the war.

One of us (Ferriss) collected a few days, less than a week, in the Santa Catalinas, Mount Lemon and Soldier Camp, in 1910; again much of the time from May to October in 1913, on the southern slope, around Mount Lemon, Soldier Camp, Marble Peak and on the northern mesa, about Brush Corral. Again a month was spent in 1917, at Sabino Basin, Bear Creek, and Brush Corral, the Rincon Peaks and the Galiuros. The guide, Frank Cole, on a hunting trip, brought in Sonorellas from the Tortillitas and from the Cañada del Oro section of the Santa Catalinas. Many inviting prospects in these mountains remain neglected. They surely contain species still unknown.

Life is rapid in snaildom, decay a slow process in an arid climate; and possibly these fat cemeteries in the basements of Sonorella slides merely represent the natural death rate of many years. It may be that one living inhabitant to one hundred skeletons is the right proportion. However an impression grows upon the collector as he digs in the arid foothills, that in earlier times there were periods or seasons more favorable to snail life—seasons with more moisture, more vegetation, and a deeper humus. The steep mountain gulches with walls on either side thrown above the surrounding surface quite plainly speak of days when the floods were greater than any known in modern times. These boulder bulwarks contain potsherds and other evidence of human occupation; also Sonorellas. As collecting grounds they are often preferable to the large slides farther up the mountain. Among these boulders, in the hot sunlight, we found the largest Sonorella. Measured crudely in the field it had a diameter of 33 millimeters.

In collecting Sonorellas and Oreohelices from arid to humid zones in the same canyon or mountain, one gets the impression that the differences of size are mainly a matter of the breed; that they are racial, rather than due to length of growing season, supply of food or climatic comforts. We naturally search ideal environments of food, shade and shelter for robust races, and expect to meet the pigmy forms in hot, dry and barren places. Often what we find is the reverse of this. On one climb in 1918, at Kitt's Peak, a large

and robust *Sonorella* was found at a low elevation in a barrier of boulders, so dry and barren the snails would necessarily lie dormant a large part of the year. At a thousand feet higher, beside a stream of running water, came in a much smaller breed; and, 1500 feet above number two, with an ideal situation as to a moist atmosphere, food, shelter and snail comfort, lived a pigmy *Sonorella* of about 12 millimeters in diameter.

Again on the Kaibab Plateau in 1909, every colony of *Oreohelix strigosa depressa* seemed a little different from all other colonies. At Two Spring Canyon with running water all the way, the pygmies were at the higher station in a grove of quaking asp. Every colony increased in size and color brilliance at a regular pace down the canyon. Here seemed proof positive of the advantage of a longer growing season. Over the ridge in Snake Gulch the order was reversed, for the larger shells were at the top in a dry situation, and their size seemingly decreased in proportion to the mileage as we descended along a running stream. In Jacobs Canyon, running parallel to Snake Gulch, dry all the way, the large and gaudy shells were midway, the smaller and paler above and below. Food conditions may have had some influence in the development of these races but if so the evidence was not apparent. In the field we meet contradictions continually beyond our understanding, but perhaps we may have a better comprehension before the survey of the Southwest is completed.

#### HELICIDÆ.

*Sonorella odorata* n. sp. Pl. III, figs. 1 to 4.

The shell is depressed, umbilicate, the umbilicus contained about  $7\frac{1}{3}$  times in the diameter of shell; buffy-citrine below, somewhat lighter than isabella color above, with a chestnut brown band at the shoulder. The first half whorl has irregular radial wrinkles soon passing into a low granulation, the last embryonic whorl granular, over which there are close decurrent threads, interrupted into short dashes on the upper part of the whorl. Subsequent whorls are very minutely granular, somewhat dull, the granulation effaced at the base, which is more glossy. The last whorl shows also numerous faint spiral striae. The whorls are quite convex, the early ones increasing slowly, the last widening rapidly, rather abruptly descending close to the aperture. The aperture is elliptical-lunate; peristome is narrowly expanded throughout, dilated at the columellar insertion.

Alt. 11.4, diam. 19.5 mm.;  $4\frac{1}{2}$  whorls (type).

" 13.4, " 23.3 "  $4\frac{2}{3}$  " (Station 18, 1917).

" 13.2, " 22 " (Station 18, 1917).

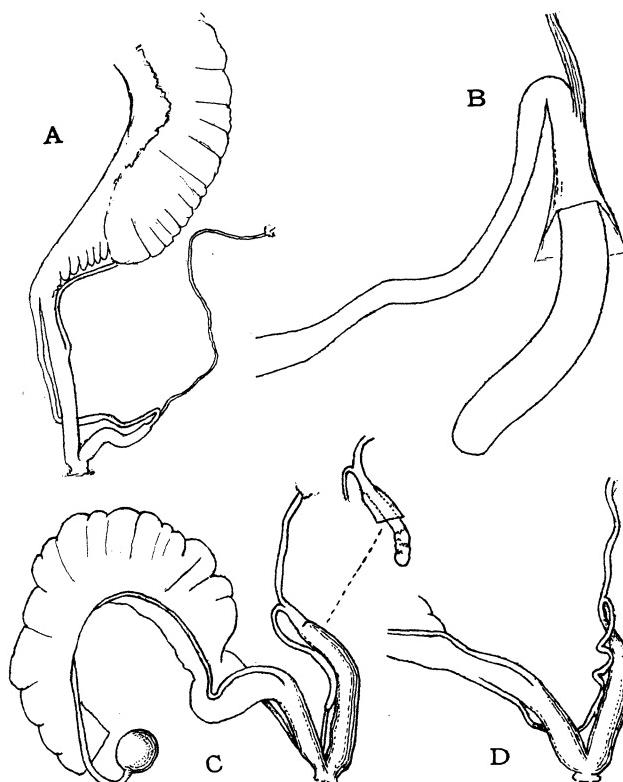


Fig. 1. Genitalia of *S. odorata*. *a*, No. 119,032; *b*, penis-papilla of same much enlarged; *c*, No. 119,035, with detail of penis-papilla; *d*, No. 119,034.

The sole is tripartite in color, the side areas being somewhat darker. The back and head are quite dark in most alcoholic specimens, black in life, the tips of the tubercles lighter.

The penis is small, containing a cylindric papilla with rounded end, about two-thirds as long as the penis. The penial retractor is inserted upon the epiphallus not far from its base. The flagellum is present as a very minute but distinct bud in most of the specimens opened, but in two it was not seen though looked for. In the specimen No. 119,032 (figs. 1*a*, *b*), the male organs are evidently not fully developed, the penis and epiphallus being small and short, while the retractor muscle is correspondingly longer, making the total length about normal, the individual being of full size though not adult. Measurements of the organs in mm. follow:

| LOCALITY.                                | Penis. | Penis-papilla. | Epiphallus. | Flagellum. | Perial retractor. | Vagina. | Spermatheca and duct. | Diameter of shell. | Number.  |
|--|--------|----------------|-------------|------------|-------------------|---------|-----------------------|--------------------|----------|
| Head of Alder Canyon . . .               | 6.6    | ...            | 7.5         | trace      | 7                 | 6       | ...                   | 20                 | 119,033  |
| " " "                                    | 6.5    | 4              | 7.2         | 0          | 2.5               | 7       | ...                   | 20                 | 119,033  |
| N.-E. side Mt. Lemon . .                 | 6      | 3.3            | 8           | trace      | 5                 | 4.5     | ...                   | 19                 | 119,034  |
| " " "                                    | 6      | 4              | 5           | trace      | 7                 | 4       | ...                   | 24                 | 119,035  |
| " " "                                    | 7      | 5              | 8           | trace      | 6                 | 5       | ...                   | ..                 | 119,035  |
| S. of spring, Mt. Lemon <sup>2</sup> . . | 3.5    | 2              | 3.2         | 0          | 13.5              | 5       | ...                   | 20                 | 119,032  |
| <i>S. o. marmoris</i> , Station 36       | 10.7   | 6.5            | 8           | dist.      | ...               | 8       | ...                   | 20                 | 109,075a |

Santa Catalinas above 7500 ft.: Mt. Lemon, Stations 5 and 6 (1911), 32 and 37 (1913), on the trail to Webber's and other places. Soldier Camp, Bear Wallow, Head of Alder Canyon (type loc., No. 119,033). Kellogg Peak, southeastern side.

Rincons at station 22, Spud Rock Ranger Station, and Station 20, on the north slope.

It lives in deep humid forest in colonies, as our eastern helices do, under logs and bark of quaking asp and Arizona fir, sometimes by dozens. Only at Spud Rock it was found deep in rocks, also humid. It is a timber snail of the Canadian zone forest. In general aspect the shell reminds one of the Californian helices.

This is a common snail in the heavily wooded upper levels of the Santa Catalinas, taken at many stations. When picked up it emits a strong unpleasant odor recalling that of the goldenrod of Thunderhead mountain in East Tennessee (probably *Solidago odora*). This was first noticed at Kellogg Peak. When picked up the snail shot out two or three drops of liquid six inches or more (evidently expelled from the lung as the foot is retracted). One often smelled them before finding any. But three or four shells broken by mice or squirrels were noticed in the course of collecting, and it may be that the snail-eaters object to the smell.

By the genitalia this species is related to *S. clappi* of the Santa Rita range, and *S. ferrissi* of the Dragoons, though differing from both in several details. The shell is most like *S. clappi*. It differs from other Santa Catalina species by the minute granulation of the surface, which gives it a dull, silky luster.

The color is rather variable. At Soldier Camp (Fig. 4), Cañada

<sup>2</sup> Specimen not fully mature.

del Oro and some other places the general hue is cinnamon or cinnamon-buff, opaque, and the size small, diam. 18 to 20 mm. The smallest adult seen measures 17 mm. in diameter.

Specimens from the Rincons, Station 22 (1917), are pale cinnamon or greenish above, fading to a pale, bluish-gray on the base, the band with narrow, indistinct paler borders or without them. The lip is conspicuously brown-edged. The umbilicus is generally wider than in the Catalina shells. One perfect shell and another broken one in this lot are albinos, or at least the tint is very pale, and there is no band. These shells are found deep in a rock slide in a quaking asp thicket. At Station 20 (1917), on the northern slope of the Rincons, two dead but fresh shells were found in a day's search.

**Sonorella odorata marmoris n. subsp. Pl. III., figs. 6 to 6b.**

The shell is more solid than *S. odorata*, opaque; cinnamon, paler around the umbilicus and on both sides of the chestnut-brown band. Last whorl is decidedly more depressed than in *S. odorata*, and is narrower as viewed from above. The umbilicus is wider. The aperture is much smaller.

Alt. 10.4, diam. 20 mm.;  $4\frac{2}{3}$  whorls (type).

" 9, " 18 "  $4\frac{1}{2}$  " "



Fig. 2. Genitalia of *S. o. marmoris*, No. 109,079, with detail of penis-papilla.

Santa Catalina Mountains: Marble Peak, on the east side above the rock slide; old Dan's Gulch on the northwest side, type loc.; ridge running toward Mt. Lemon; Ferriss 1911 and 1913. Type No. 109,075 A. N. S. P.; paratypes 109,075a, also in Ferriss collection.

Genitalia (fig. 2) in general similar to *S. odorata* but the penis and papilla are decidedly longer and there is a flagellum, well developed for a *Sonorella*. Measurements of the organs are given in the table on page 287.

It lives in relatively dry rock slides, with the smooth *Sonorella marmorarius*, high on Marble Peak and its flanks, thus differing in habits from *S. odorata*. The shell is readily separable from *odorata*, and perhaps it should be considered a separate species. It has the same peculiar odor.

***Sonorella sabinoensis* n. sp.** Pl. IV, figs. 1 to 5d.

The shell is rather narrowly umbilicate (width of umbilicus contained 8 times in that of shell in the type specimen), rather solid; cinnamon-buff, broadly zoned with white (or whitish) on both sides of the chestnut-brown band above the periphery. The surface is glossy; embryonic whorls having the usual sculpture of the *hachitana* group, granular, with divaricating protractive threads below and retractive above; subsequent whorls delicately marked with growth-lines. Suture descends moderately in front. The aperture is large, oblique, rotund-oval. Peristome narrowly expanded, dilated at the umbilical insertion.

Alt. 12, diam. 21.2 mm.; aperture 12x13 mm.; 4½ whorls.

Santa Catalina mountains, Arizona, in Sabino canyon (type loc. Station 16, 1913) and its tributaries, Sycamore canyon and Mt. Lemon Fork, from about 3000 to 6000 feet elevation. Also Rock and Vantana canyons, west of Sabino, and Bear canyon eastward.

It is a species of the dry, sun-baked rock-slides, living ones found only deep in the crevices, in the lower levels of desert vegetation. The Sabino Basin, Sycamore and Bear canyon localities are below the pine belt, in arid country, with some oak, juniper and sycamore. The species is not known to occur in the humid upper forest.

Genitalia (fig. 3, *a-d*) resembling those organs in *S. marmorarius*. The penis is thin, not swollen basally. The penis-papilla is slender and corrugated, as in the other species, and nearly as long as the penis (fig. 3*a*). The flagellum is either minute or wanting.

| Mus. No. | Penis. | Papilla. | Epiphallus. | Flagellum. | Vagina. |                         |
|----------|--------|----------|-------------|------------|---------|-------------------------|
| 109,097  | 10     | 7        | 8           | 0          | 9       | Type, fig. 3 <i>c</i> . |
| 109,092  | 9.5    | 8        | 7           | 0          | 7.3     |                         |
| 109,094  | 10.5   | 10       | 9           | —1         | 9       | Fig. 3 <i>d</i> .       |
| 109,087  | 9      | 7        | 6           | 0.3        | 8.5     |                         |
| 109,098  | 8.5    | 8        | 6.5         | 0.5        | 6.5     | Fig. 3 <i>a, b</i> .    |

Shells from the type station measure from 20 to 24 mm. diameter. The relative size of the aperture also varies within rather wide limits. In the type specimen (pl. IV, figs. 2-2*b*) the width of aperture is con-

tained about 1.63 times in that of the shell, and in another locotype (pl. IV, figs. 3-3b) it is contained nearly 1.8 times. In the smaller mouthed individuals the umbilicus is somewhat larger and less covered, and the last whorl, viewed from above, is not so wide. We have tried in vain to use these characters for a separation of the series (some hundreds of shells); but while the extremes in size of aperture appear quite distinct, the distinction could not be carried through, as nearly every station supplied individuals with large, intermediate and small apertures.

The specimens from low in Sabino canyon usually have more solid, thicker shells than those from higher; but this is not always the case.

It is a species of the arid mountains, confined to lower elevations than *S. marmorarius*.

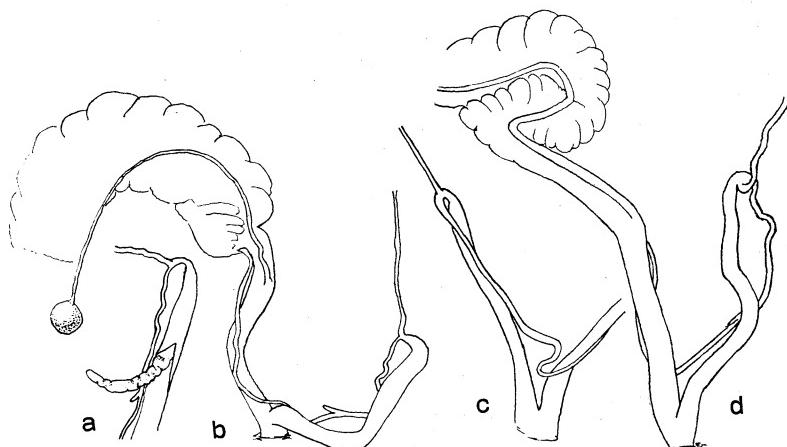


Fig. 3. *Sonorella sabinoensis*, Sabino Canyon, genitalia. a, b, No. 109,098; c, No. 109,097; d, No. 109,094.

The smallest shells, diam. 19 mm., were found at Station 15, low in Sabino canyon (about 4,000 ft.); but others up to 25 mm. diam. occur in the same place. The largest, 27 mm. diam. are from Station 9, 1913, the bluffs opposite Station 15. One of this lot is figured, pl. IV, figs. 4-4b.

The degree of depression is variable in the same lot. Specimens selected from a station on Vantana canyon measure:

Alt. 14.5 diam. 26, mm. (largest).

" 13.2 " 25, " (most depressed).

" 16.4 " 24.8, " (" elevated).

" 12.2 " 20, " (smallest).

Figures 5 to 5d are depressed and elevated shells from Bear canyon.

**Sonorella sabinoensis occidentalis n. subsp.** Pl. V, figs. 1 to 1b.

The shell appears indistinguishable from *S. sabinoensis*.

Alt. 16, diam. 28 mm.; 5 whorls.

|          |      |        |
|----------|------|--------|
| " 17.3 " | 27   | " 5 "  |
| " 16     | 25   | "      |
| " 14     | 23.7 | " 4½ " |
| " 14     | 22.3 | " 4½ " |

This form is separated from *S. sabinoensis* solely on account of the difference in the penis, which is enlarged at the base in *occidentalis*, slender in *sabinoensis*. While the Pima canyon shells are distinguishable from the large-mouthed typical forms of *sabinoensis*, we can find no difference in the *sabinoensis* with slightly smaller aperture, such as those from Sabino canyon Station 9 (which agree in genitalia with the type of *sabinoensis*). No specimens with the penis swollen basally were found among the numerous Sabino canyon individuals opened.

The head and back are hair brown, fading to drab on the sides, the tail and entire sole being dull chamois to dull cream-buff.

Western end of the Santa Catalinas; type No. 119,491, from Station 36, east side of Pima canyon. Also on the west side, Station 37 (Pusch Ridge); Station 43 (1917), northeast of Sutherland's ranch, in the foothills; Station 45, in the large canyon north of Romero canyon (eastward from Sutherland's).

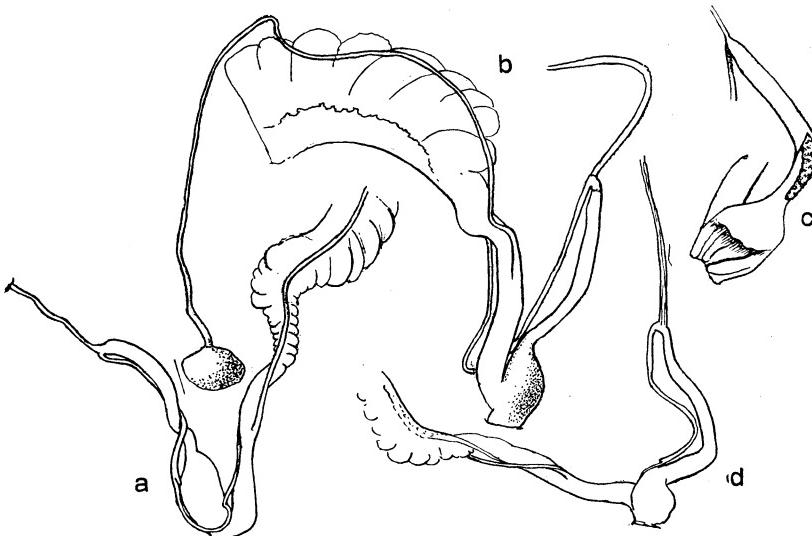


Fig. 4. Genitalia of *S. s. occidentalis*. a, No. 118,052. b, No. 118,045, with detail of penis and papilla at c; d, No. 118,056, canyon north of Romero Canyon.

Genitalia (Fig. 4a-d). The penis is slender except at the base where it is suddenly dilated. Internally there is a short, sinuous fleshy fold and several minor folds in the dilated part of the penis where it passes into the atrium, which also contains several fleshy ridges. The papilla is long, slender and corrugated. Penial retractor is terminal and enveloping base of the epiphallus, as usual. The epiphallus is nearly as long as penis, with a slight distal swelling in place of a flagellum. The vagina is shorter than the penis. Measurements of the organs in mm. follow:

| Mus. No. | Penis. | Papilla. | Epiphallus. | Flagellum. | Vagina. | Spermatheca and duct. | Locality. |
|----------|--------|----------|-------------|------------|---------|-----------------------|-----------|
| 118,045  | 10     | 8        | 8           | 0          | 6       | 32                    | Sta. 36.  |
| 118,052  | 8.5    | 6        | 7.5         | minute     | 4       | 23                    | Sta. 37.  |
| 118,056  | 9      | 6.5      | 7.5         | "          | 6       |                       | " 45.     |

The series of 60 specimens from Pima canyon consist chiefly of dead shells. The average size appears to be slightly less in the specimens from the western side of the canyon, forming the eastern slope of Pusch Ridge.

There are three "dead" specimens from "Pusa Ridge" (?=Pusch Ridge) in the U. S. National Museum, No. 271,011, collected by Barber. The diameter is about 22 mm.

The specimens from the canyon north of Romero (opening northwestward), Station 45 (1917), have the same range of variation noted in Sabino canyon *S. sabinoensis*. There are depressed, more openly umbilicate shells, together with smaller, usually less depressed shells with relatively larger aperture and smaller umbilicus,  $\frac{1}{3}$  to  $\frac{1}{2}$  covered by the expansion of the columellar lip; also a few specimens transitional in these characters. 14 examined.

Alt. 15.4, diam. 27.3 mm.,  $4\frac{3}{4}$  whorls (largest).

" 15.6, " 23 "  $4\frac{1}{2}$  "

" 14.3 " 22 " (smallest).

The genitalia do not differ from Pima canyon shells.

Seven shells from Station 43 (1917) measure: diam. 21, 21.5, 23.5, 23.7, 24, 24.4, 24.4 mm.

All of the localities for this form are in the arid lower zone of the range.

*Sonorella sabinoensis buehmanensis* n. subsp. Pl. V, figs. 2 to 3b.

Typically the shell differs from *S. sabinoensis* by being more solid and more elevated, only very slightly paler near the shoulder band, and with nearly one whorl more in examples of the same diameter.

Alt. 16.7, diam. 25.6 mm.;  $5\frac{1}{3}$  whorls (type; Figs. 2-2b).

- " 17, " 25.2 "  $5\frac{1}{4}$  " (topotype).
- " 15.7 " 23 "  $5+$  " ( " ).
- " 17.7 " 25.8 " 5 " (Sta. 43).
- " 13.7 " 21.5 "  $4\frac{3}{4}$  " ( " ).
- " 13 " 21 "  $4\frac{2}{3}$  " ( " ).

Buehman canyon, in the eastern part of the Santa Catalina Mountains, the type from Station 44 (1913), near the Korn Cobb mine. Also at Stations 41, head of Sycamore gulch, tributary to Buehman canyon, 42, Buehman canyon at the Brush Corral, and station 43, Buehman canyon a mile below the Brush Corral Ranger Station.

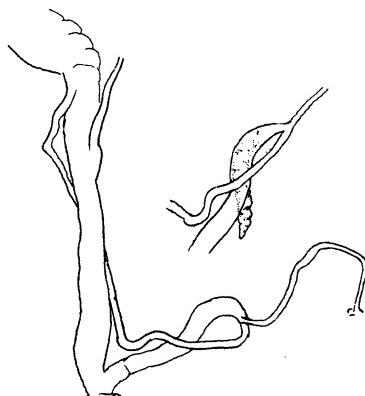


Fig. 5. Genitalia of *Sonorella sabinoensis buehmanensis*, No. 109,196.

There is considerable variation in the shells from Buehman canyon, in size, degree of elevation and number of whorls; yet unless anatomical differences are found, we consider them all of one race. As yet, only the typical form has been dissected.

Specimens from Station 41 (1913), from the head of Sycamore Gulch, have the umbilicus slightly more open than in typical *buehmanensis*, and the borders of the shoulder-band are paler; thus approaching the larger forms of *S. sabinoensis*.

In Stations 42 and 43 the size varies widely, and the smaller specimens have only a fraction of a whorl more than *sabinoensis*, from which they differ by the smaller aperture. One figured (pl. V, figs. 3-3b, Station 43) measures: alt. 13.7, diam. 21 mm. In the same lots the larger shells have a diameter of 25 mm. or slightly more.

Like other species of the dry lower mountains, living snails are rare. In one rock slide in Buehman Canyon, 360 fairly good "bones" were found, and only 8 living snails.

**Sonorella hesterna** n. sp. Pl. IV, figs. 6, 6a, 6b.

A long series of dead shells was taken at Station 148 (1917) in a rock slide on the south side of the Tucson-Benson highway, near the cave on Shaw's ranch, southern foothills of the Rincons, at about 3,500 feet. They are smaller and more solid than *S. rinconensis*, and the umbilicus is somewhat smaller. It is more depressed and has a wider umbilicus than *S. sabinoensis*. In color and surface it resembles the latter species. The freshest shells are between cinnamon and tawny-olive, fading around the umbilicus, white on both sides of the chestnut-brown band. The suture descends rather abruptly to the aperture, but not quite so deeply as in *S. hachitana*.

Alt. 13.5, diam. 22.4 mm. (type).

" 14.7, " 25.9 "

In a series of 37 adult examples, the smallest measures 20.1 mm. in diameter, the largest 25.9 mm. They run as follows:

Diam. 20-20.9 mm., 4 specimens.

|   |         |   |    |   |
|---|---------|---|----|---|
| " | 21-21.9 | " | 11 | " |
| " | 22-22.9 | " | 7  | " |
| " | 23-23.9 | " | 9  | " |
| " | 24-24.9 | " | 4  | " |
| " | 25-25.9 | " | 2  | " |

The station is an extremely arid one. It is a true desert *Sonorella*. The status of the form is uncertain, but it can scarcely be linked with any of the Santa Catalina or Rincon species, so that, while we do not like to describe a *Sonorella* without examination of the soft anatomy, there seems nothing else to do in this case. Its status may be revised when living examples come to hand.

**Sonorella marmorarius** n. sp. Pl. III, figs. 9, 9a, 9b.

The shell is depressed; rather solid, umbilicate (the width of umbilicus contained about 7 times in that of the shell, suddenly widening at the last whorl to about double its former width); light pinkish cinnamon, paler around the umbilicus, and whitish on both sides of the chestnut-brown band above the periphery. The surface is glossy. Embryonic shell of  $1\frac{1}{2}$  whorls, the last of which is densely, irregularly granular, with indistinct protractive and retractive threads (when unworn), subsequent whorls delicately marked with growth-lines, and under the lens showing some weak spiral impressed lines in places on the upper surface of the last whorl. The suture descends rather deeply in front. Aperture is quite oblique, oval. Peristome expanded throughout, with a gray edge, somewhat thickened within, the margins generally connected by a roughened callous ridge in fully adult shells.

Alt. 14 diam. 25 mm.; aperture 11.2x13.6 mm.;  $4\frac{3}{4}$  whorls.

Marble Peak, Santa Catalina Mountains, Arizona; type loc. Station 26, 1913, quartzite slide on Marble Peak. Also found at Station 3, 1911, slide above Apache mine; Station 4, 1911, top of ridge south of the Peak; Station 38, 1913, north side of Marble Peak; "Joliet Cave," and other stations on the same mountain.

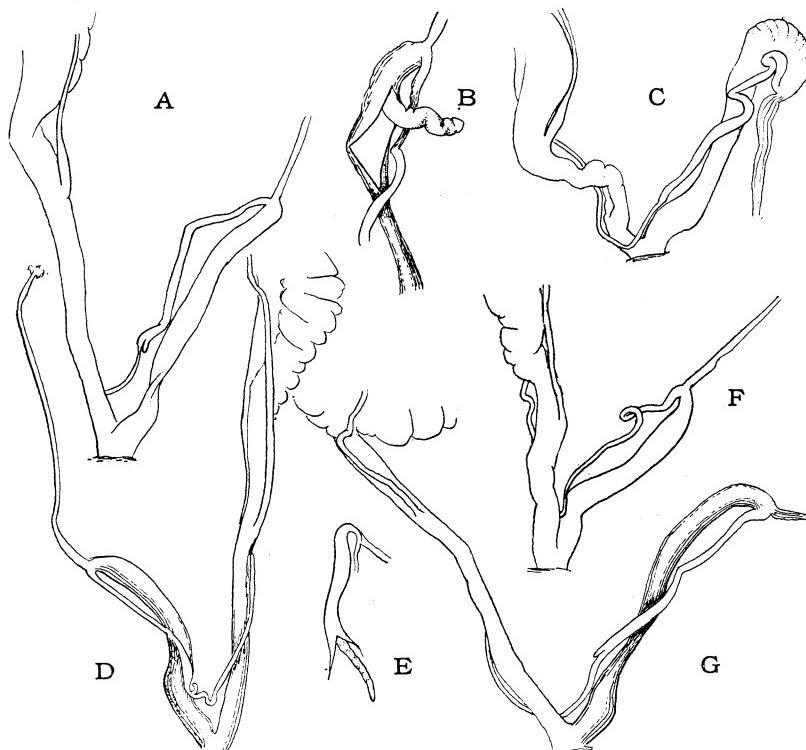


Fig. 6. Genitalia of *Sonorella marmorarius*, a, No. 109,077; b, c, No. 109,071; d, No. 109,039; e, No. 109,083; f, No. 109,084; g, No. 109,078.

Genitalia (Fig. 6a-g). The penis is thin-walled, very weakly or usually not noticeably enlarged near the atrium, containing a slender tapering, corrugated papilla, half to two-thirds or more the length of penis. Epiphallus somewhat shorter than penis, typically terminating in a little flagellum, but this is often rudimentary or wanting. Penial retractor long, inserted on apex of penis and base of epiphallus. The vagina is but little shorter than the penis. Lengths of the organs in mm. follow, the specimens all from stations on Marble Peak:

| Mus. No. | Penis. | Papilla. | Epiphallus. | Flagellum. | Retractor. | Vagina. | Station. | Fig.   |
|----------|--------|----------|-------------|------------|------------|---------|----------|--------|
| 109,078  | 12.5   | 7.3      | 8           | —1         | .....      | 10      | 26       | 6g.    |
| 109,077  | 12     | 8        | 10          | 1          | 8          | 11      | 26       | 6a.    |
| 119,039  | 9      | 6        | 7.3         | 1          | 12         | 8.5     | 4(1911). | 6d.    |
| 119,040  | 10     | 8.5      | 7           | 0.5        | .....      | 9.5     | 3(1911). | ...    |
| 109,074  | 11.5   | 10       | 9           | 1          | .....      | 9       | .....    | ...    |
| 109,083  | 8.5    | 7        | .....       | 0.5        | .....      | 7       | 22       | 6e.    |
| 109,084  | 9      | 7        | .....       | 0          | 11         | 5.5     | .....    | 6f.    |
| 109,080  | 12.5   | 6        | .....       | 0          | .....      | 7       | 38       | ...    |
| 109,071  | 11.5   | 6        | 7.3         | 0          | .....      | 6       | Cave     | 6b, c. |

This species is closely related to *S. hachitana* (Dall) and *S. compar* Pils. It has the peristome more thickened within than the former and differs from *S. compar*<sup>3</sup> by the more solid shell, more thickened peristome, etc.

The more widely open umbilicus distinguishes it readily from other Sonorellas of the *hachitana* group found in the Santa Catalinas.

Other specimens of the original lot from the type locality measure:

Alt. 15 diam. 26.3 mm. Alt. 13.8, diam. 24 mm.

“ 15.3 “ 24.6 “ “ “ 23 “

“ 13 “ 23.6 “ “ 12.5, “ 22 “

The largest examples were taken at Station 3, two measuring:  
Alt. 16.4, diam. 28.2 mm.; 5 whorls.

“ 17 “ 28 “ 5 “

Marble Peak and Apache Camp have oak, juniper and sycamore wood on the lower slopes; the crest of the ridge, the head of the main “slide,” is in the pine belt.

**Sonorella marmorarius limifontis** n. subsp. Pl. III, figs. 5, 5a, 5b.

The shell is depressed, openly umbilicate (the width of umbilicus contained 7 times in that of the shell); whitish, faintly buff near the suture and on the spire, having the usual chestnut-brown band. Last whorl wide, very deeply descending in front. Surface glossy, weakly marked with growth-lines as in related species of the *hachitana* group, and showing weak traces of impressed spiral lines on the upper surface of the last whorl. The last whorl descends deeply and abruptly in front. The aperture is very oblique, rounded-oval. Peristome somewhat expanded, slightly thickened within.

<sup>3</sup> *Sonorella compar*, new name for *Sonorella ashmuni* Pils., Proc. A. N. S. Phila. 1905, p. 259, pl. 17, figs. 9-14. Not *S. ashmuni* Bartsch.

On comparison with the type of *S. ashmuni*, this species is seen to differ conspicuously by the more depressed and more openly umbilicate shell.—H.A.P.

Alt. 13.3, diam. 22.3 mm.; 5 whorls.

" 14 " 23 " scarcely 5 whorls.  
" 16 " 26.5 " 5 whorls.

Santa Catalina Mountains at Station 17, bluffs near Mud Springs, on Pine Canyon.

The last whorl descends more than in *S. marmorarius*, the aperture is more oblique, and the color of adults is paler. The immature shells have more of a cinnamon tint than the adults.

The spiral lines mentioned in the description are usually very faint, often scarcely discernible, but in the largest example they are quite distinct. The umbilicus sometimes varies to somewhat smaller than in the type specimen.

Mud Springs, on Pine Canyon, a branch of Sabino above Sabino Basin, is a walled hole in the mud. It is on the trail from Sabino Basin to Soldier's Camp, the elevation about 7,000 ft. It is in the pine zone. The *Sonorella* was found in the first rocks east of the spring along the trail. Also at the foot of a high cliff, in stratified "porphyry," in a ravine heavily wooded with cypress (*Cupressus arizonica*), about a mile southeast of the springs.

***Sonorella marmorarius imula* n. subsp. Pl. III, figs. 7, 7a.**

At Stations 17 and 19 (1917), on a limestone hill 6 miles west of Brush Corral Ranger Station, north of Alder Springs, in the northern foothills of the Catalinas, many specimens were taken, chiefly dead, differing from typical *marmorarius* by the somewhat darker color, and by having about a half of a whorl more in examples of similar diameter.

Alt. 26.5, diam. 15 mm.; 5½ whorls.

Eighty-five specimens from Station 19, all of the adults collected, measure as follows:

|                        |      |      |      |      |      |      |      |      |
|------------------------|------|------|------|------|------|------|------|------|
| Diam. in mm.....       | 22.3 | 22.4 | 22.5 | 22.6 | 22.9 | 23   | 23.1 | 23.2 |
| Number of specimens... | 1    | 1    | 1    | 3    | 1    | 3    | 1    | 3    |
| Diam. in mm.....       | 23.3 | 23.4 | 23.5 | 23.6 | 23.7 | 23.9 | 24   | 24.1 |
| Number of specimens... | 2    | 3    | 2    | 2    | 3    | 1    | 4    | 2    |
| Diam. in mm.....       | 24.2 | 24.3 | 24.4 | 24.5 | 24.6 | 24.7 | 24.8 | 24.9 |
| Number of specimens... | 6    | 2    | 6    | 4    | 5    | 3    | 2    | 3    |
| Diam. in mm.....       | 25   | 25.1 | 25.3 | 25.4 | 25.5 | 25.6 | 25.9 | 26   |
| Number of specimens... | 4    | 2    | 2    | 2    | 2    | 1    | 2    | 1    |
| Diam. in mm.....       | 26.2 | 26.3 | 26.4 | 26.5 |      |      |      |      |
| Number of specimens... | 1    | 1    | 1    | 1    |      |      |      |      |

As the error in measuring may be at least 0.1 mm., it will be seen, if a curve is plotted, that the mode for diameter is at about 24.4 mm., and the total variation 2.1 mm. in either direction.

A specimen having the umbilicus exceptionally narrow is illustrated in pl. 4, figs. 8-8b. The spire is also narrower than in the typical form; yet it seems unlikely that there is more than one species in the lot.

**Sonorella galiurensis** n. sp. Pl. V, figs. 5 to 6b.

The shell is umbilicate (the width of umbilicus contained about 9 times in that of the shell), between cinnamon-brown and sayal-brown in color, fading on the base, and much paler on both sides of the broad chestnut-brown band above the periphery. Glossy; embryonic whorls closely pitted-granulate, with the usual protractive threads; subsequent whorls lightly marked with irregular growth-lines. The last whorl is wide and descends somewhat in front. The peristome is narrowly expanded. The parietal callus usually has a thickened edge in fully adult shells.

Alt. 16.7, diam. 27.5 mm.; 5 whorls. (type, Sta. 30).

" 16, " 27.4 " 5 " (Sta. 30).

" 16.4, " 25 " 5 " (Sta. 30).

" 16.7 " 30.5 " 5 " (Sta. 34).

Galiuro Mountains at the following Stations (1917):

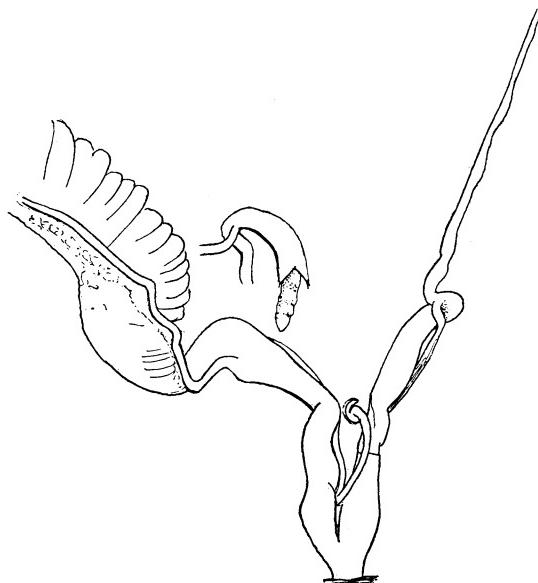


Fig. 7. Genitalia of *Sonorella galiurensis*, No. 118,122.

24. Southern slope of mountains at eastern gate of John Rhodes' ranch, among boulders on mesa.
26. Rhodes' canyon.
27. Northern slope, amphitheatre on Whitlock ranch.
28. Foot of main gulch facing north, same amphitheatre.
29. Farther up same gulch.
30. "Porphyry" slide on trail 1½ miles south of Copper Creek Mining Camp. Type locality.
31. Camp at smelter, Copper Creek.
32. Rock slide sloping west, on trail half way between Copper Creek Camp and Table Mountain.
33. "Porphyry" slide in forks of creek 2 miles east of Table Mountain.
34. Slide near the preceding.
35. Cliffs on northeastern slope of Table Mountain.

Genitalia (fig. 7). The general proportions are as in *S. marmorarius*. The penis has a long, very thin sheath about the basal part, not seen in *marmorarius*; its lower portion is somewhat swollen and has several small longitudinal folds within. Retractor muscle long. Papilla weakly annulate, about half as long as the penis. There is the usual short flagellum. The vagina about equals the penis in length.

|                           |     |     |
|---------------------------|-----|-----|
| Length of penis . . . . . | 10  | mm. |
| papilla . . . . .         | 5   | "   |
| epiphallus . . . . .      | 7   | "   |
| flagellum . . . . .       | 1.5 | "   |
| vagina . . . . .          | 9   | "   |

Museum No. . . . . 118,122.

This form is much like *S. marmorarius*. The shell is slightly more capacious and darker colored, and there is some difference in the penis. Its habitat is separated from that of *marmorarius* by the valley of the San Pedro River. The elevation is much less than that inhabited by *S. marmorarius*.

20 living specimens from Station 30, all taken, measure as follows:

| Diameters in mm...      | 25  | 25.5 | 26  | 26.5 | 27  | 27.5 | 28  | 29  |
|-------------------------|-----|------|-----|------|-----|------|-----|-----|
| No. specimens . . . . . | (1) | (1)  | (2) | (2)  | (3) | (2)  | (8) | (1) |

17 specimens from Station 24, a southern slope:

| Diameters . . . . .     | 24  | 24.5 | 25  | 26  | 26.5 | 27  | 28  | 28.5 | 30.5 |
|-------------------------|-----|------|-----|-----|------|-----|-----|------|------|
| No. specimens . . . . . | (1) | (2)  | (3) | (2) | (4)  | (1) | (2) | (1)  | (1)  |

**Sonorella tortillata** n. sp. Pl. V, figs. 4, 4a, 4b.

The shell is umbilicate (width of umbilicus contained about  $8\frac{1}{2}$  times in that of the shell), pinkish buff, fading to white around the umbilicus and paler near the chestnut-brown band which revolves above the periphery of the last whorl and shows very narrowly above the suture on most of the penult whorl. The surface is glossy;

embryonic shell about  $1\frac{1}{3}$  whorls, the first half whorl having some radial wrinkles, the rest of the embryonic portion closely irregularly granulose, and having fine, rather indistinct, tangential (protractive) threads, often visible only near the suture. Subsequent whorls have the usual fine growth-lines. The whorls increase slowly at first, the last one very wide, suture descending slightly in front. The aperture is rounded oval-lunate. Peristome is well expanded.

Alt. 15.5, diam. 27 mm.; aperture alt. 14.3, width 15.8 mm.;  $4\frac{2}{3}$  whorls.

Tortillita Mountains, Pinal Co., Arizona, the type, No. 118,053, from Station 41 (1917), east side of Hog Canyon; also found at Station 40, west side of same canyon near the cement dam, and Station 42, south slope of mountains east of Hog Canyon.

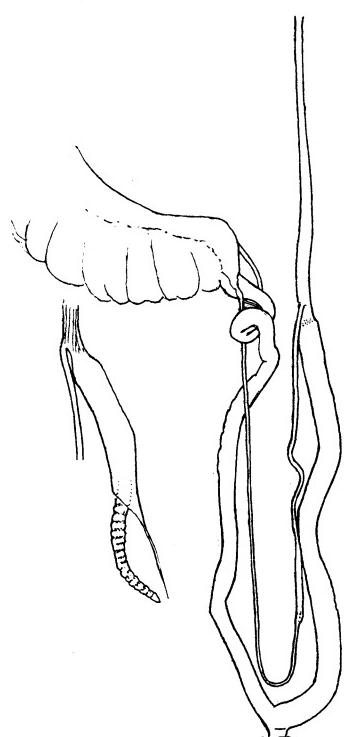
Genitalia (Fig. 8). The penis is very long and rather slender, with muscular walls, containing a long, slender, corrugated, tapering papilla. The epiphallus is shorter than the penis, without a distinct flagellum, though there seems to be a rudimentary one concealed in the integument. The penial retractor is long. Length of vagina is about equal to the penis.

By the long penis and vagina this species is related to *S. rinconensis*, but in that snail these organs are far longer. *S. santaritana* is even more like *S. tortillita* in genitalia,

Fig. 8. Genitalia of *Sonorella tortillita* with detail of the penis papilla.

but the shell is flatter, the whorls of smaller caliber. None of the Santa Catalina species has the vagina and penis nearly so long as in *S. tortillita*. The larger shells referred to *S. sabinoensis occidentalis* are closely similar.

The embryonic sculpture described is in large part effaced in the fully adult shells found. The color, too, is somewhat faded. In the young and barely full-grown examples it is decidedly darker than described.



The largest specimen from the type locality measures 17.2x28.6 mm.; the smallest, 12.5x23.2 mm.; very few are under 25 mm. diameter. The largest shell in the lot from the west side of Hog Canyon measures 17.5x30 mm.

The Tortillitas are arid mountains without forest.

**Sonorella rinconensis** Pils. & Ferr.

*Sonorella rinconensis* PILSBRY & FERRISS, Proc. A. N. S. Phila. 1909, p. 517, fig. 1, pl. 22, figs. 1-3, 5, 7.<sup>4</sup>

Rincon range: Rincon Peak and Wrong Mountain; Mt. Mica, only those from Rincon Peak dissected. This species was not encountered in the localities visited in 1917. It inhabits elevations above 7,500 ft., occurring in granitic rocks.

**Thysanophora hornii** (Gabb).

Santa Catalina Mountains: Stations 3 and 9, near mouth of Sabino Canyon, 4,500 ft. Station 13, mouth of Bear Canyon, 4,500 ft. Station 40, Alder Springs, 8,000 ft. Southern foothills of Rincon Mountains near the cave, Station 191 (1918). Galiuro Mountains.

**Thysanophora ingersolli** (Blaud).

Santa Catalina Mountains: Mt. Lemon at Stations C, 19, 31, 34, 37, etc., at 9,000 to 9,500 ft.

**ENDODONTIDÆ.**

**Gonyodiscus cronkhitei** (Ne.)

Santa Catalina Mountains: Station 21, Desert Laboratory Plantation, 8,500 ft. Soldier Camp. Bear Wallow. Around Mt. Lemon at Station C, spring on west side; Station 19, Congdon's Cabin; Station 28, marshy spring; Station 37; Station 22, old Lemon trail; Station 31, aspens, new trail; Station 34, 9,000 to 9,500 ft.

Rincon Mountains: Spud Rock and Catalina saddle.

**Radiodiscus millecostatus** Pils. & Ferr.

Santa Catalina Mountains: Environs of Mt. Lemon, Stations C, 19, 28, 30, 31, 34, 37 and some others, at elevation of 7,000 to 9,500 ft. Bear Wallow. Kellogg Peak. Generally distributed and locally very abundant, especially in the aspen zone.

**Helicodiscus arizonensis** P. & F.

Santa Catalina Mountains: Station 1, near weir, Sabino Canyon, 4,500 ft. Station 27, Bear Wallow. Marble Peak at Station 25, 8,500 ft., and Station 26, 8,000 ft. Rincon Mountains: Spud Rock. Galiuro Mountains, Station 24 (1917).

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<sup>4</sup> The reference to figures "1-4, 7" as given in our paper was incorrect.

**Punctum californicum** Pils.

Santa Catalina Mountains: trail from Webber's to Lemon Mountain.

**VITRINIDÆ.****Vitrina alaskana** Dall.

Santa Catalina Mountains: Station 37, north side of Mt. Lemon 9,000 ft.; trail to Webber's place.

**ZONITIDÆ.****Polita indentata umbilicata** (Ckll.).

Santa Catalina Mountains: Station A, Bear Wallow Creek. West side Mt. Lemon at Station C. Marble Peak at Stations 25 and 26, 8,000–8,500 ft. Trail from Webber's place to Mt. Lemon. Alder Spring. Rincon Mountains at Station 21 (1917), Catalina Saddle, and Spud Rock. Galiuro Mountains, Station 24.

**Striatura milium meridionalis** (P. & F.).

Santa Catalina Mountains: Station A, Bear Wallow Creek; Soldier's Camp; Station 21, Desert Laboratory plantation, 8,500 ft.; Mt. Lemon at Stations 22, 28, 31, 37, at 9,000 to 9,500 ft.; trail to Webber's Cabin; Alder Spring.

**Zonitoides arborea** (Say).

Santa Catalina Mountains: Station 21, Desert Laboratory plantation, 8,500 ft. Soldier Camp. Stations 19, 22, 37 on Mt. Lemon, at about 9,000 ft. Station 25, northwest ridge of Marble Peak, 8,500 ft. Rincon Mountains, Station 20 (1917).

**Zonitoides minuscula alachuana** (Dall).

Santa Catalina Mountains: Mt. Lemon, Bear Wallow; Kellogg Peak and Alder Spring. Rincon Mountains.

**Zonitoides singleyana** (Pils.).

Rincon Mountains.

**Euconulus fulvus** (Mull.).

Santa Catalina Mountains: Alder Springs. Soldier Camp. Station 27, Bear Wallow Creek. Mt. Lemon at Station C, 19, 22, 28, 30, 31, 34. Common up to 9,500 ft. Ridge from Marble Peak, southwest, 8,500 ft.; south side of Marble Peak. Rincon Mountains.

**VALLONIIDÆ.****Vallonia cyclophorella** Ckll.

Santa Catalina Mountains: Mt. Lemon at Stations 19, 22, 30, 31, 37, at about 9,000–9,500 ft. Marble Peak, quartzite slide on south side, 8,000 ft.

**Vallonia perspectiva** Sterki.

Santa Catalina Mountains: Marble Peak, in quartzite slide on south side, 8,000 ft., rare. Galiuro Mountains: Whitlock ranch on the northern slope.

**PUPILLIDÆ.****Pupoides marginata** (Say).

Southern foothills of Rincon Mountains near the cave, Shaw's Ranch, Station 148 (1918).

**Pupilla hebes** (Ancey).

Santa Catalina Mountains: Mt. Lemon, at head of the aspen gulch, and  $\frac{1}{4}$  mile below, on the new trail, 9,500 ft., and on the north side, 9,000 ft. Among those from the last locality, Station 37, 6 out of 128 were albinos. Station 22, ridge near Marshall Pass. It occurred in some abundance in all the localities except Station 22.

**Pupilla hebes nefas** Pils. & Ferr.

*Pupilla hebes* form *nefas* P. & F., Proc. A. N. S. Phila., 1910, p. 135.

Santa Catalina Mountains: Station 20, northeast side of Kellogg Peak, 8,500 ft., Station 27, Bear Wallow, 214 specimens. Soldier Camp, 63 specimens. Station 21, Desert Laboratory Station, 8,500 ft., 84 specimens. Station 22, ridge near Marshall Pass, rare. Station 29, Leaning Rock, south side Mt. Lemon, 9,500 ft., 15 specimens. Station 25, ridge of Marble Peak towards Mt. Lemon, 8,500 ft., 57 specimens. Station 26, "quartzite" slide on Mt. Lemon, 8,000 ft., 2 specimens. Station 28, marshy spring near trail, Mt. Lemon, 1 specimen. Rincon Mountains: Spud Rock; Catalina Saddle.

*P. h. nefas* almost always has a small parietal tooth, and is usually a little longer than *P. hebes*, with between 6 and 7 whorls. It differs from *P. syngenes* by having no crest behind the lip, though there is usually a shallow, wide depression there.

In only one of the numerous stations mentioned above were *hebes* and *nefas* found together. That was Station 22, where very few shells were taken. Lots from all of the other stations, frequently copious, were either all *hebes* or all *nefas*.

Elsewhere *P. h. nefas* has been found only in two places in the Chiricahua Mountains, at elevations estimated from 7,500 to 8,000 ft. It was not associated there with dextral *hebes*, which was found at another Chiricahua locality. We are now disposed to rank *P. h. nefas* as a well-marked subspecies.

**Chaenaxis intuscostata** (Clapp).

Southern foothills of the Rincons, near the Tucson-Benson highway, near the cave, Shaw's ranch, at about 3,500 ft.

**Gastrocopta ashmuni** (Sterki).

Santa Catalina Mountains: Slide on Marble Peak, 8,000 ft., rare.

Galiuro Mountains: Whitlock ranch, on the northern slope.

**Gastrocopta cochisensis** (Pils. & Ferr.).

Santa Catalina Mountains: Alder Springs and Station 25, southwest ridge of Marble Peak, 8,500 ft. The shells were dirty when collected, like *B. quadridens*.

**Gastrocopta dalliana** (Sterki).

Santa Catalina Mountains: Station 3, mouth of Sabino Canyon, 4,500 ft.

**Gastrocopta pellucida hordeacella** (Pils.).

Southern foothills of Rincon Mountains near the cave, Shaw's ranch, Station 148 (1918), at about 3,500 ft.

**Gastrocopta bilamellata** (St. & Clapp).

Galiuro Mountains.

**Gastrocopta quadridens** (Pils.).

Santa Catalina Mountains: Stations 30, 31, 37, and all around Mt. Lemon at 9,000 to 9,500 ft. Soldier Camp, one specimen. When found alive, the shell is rather copiously plastered with dirt, probably attached by the mucous of the animal.

**Gastrocopta pilsbryane** (Sterki).

Santa Catalina Mountains: Station 3, mouth of Sabino Canyon, 4,500 ft. Alder Springs, very abundant. Station 27, Bear Wallow. Station 18, Soldier Camp, 8,500 ft. Station 21, Desert Laboratory plantation, 8,500 ft. Station 22, near Marshall Pass, old Mt. Lemon trail, 9,000 ft. Station 28, marshy spring, Mt. Lemon trail, 9,000 ft. Trail to Webber's cabin. Station 31, north side of Mt. Lemon. Station 26, quartzite slide on Marble Peak, 8,000 ft. Galiuro Mountains at Whitlock ranch. Rincon Mountains: Spud Rock.

**FERUSSACIDÆ.****Cochlicopa lubrica** (Müll.).

Santa Catalina Mountains: Station 25, ridge to peak Mt. Lemon, 8,500 ft.; Station 26, slide on Marble Peak, 8,000 ft. Rincon Mountains: Spud Rock.

**Vertigo modesta insculpta** Pils.

The shell is similar to *V. modesta* in contour, but differs by being closely and rather sharply striate on the intermediate whorls; the first whorl smooth, the last less striate than those preceding. There

is a narrow but moderately high crest close behind the outer lip. The color is chestnut-brown, becoming paler towards the apex. When alive both animal and shell are black. Teeth fine, a small supraparietal denticle being developed. The parietal and lower palatal folds are rather large. Length 2.6, diam. 1.35 mm.;  $5\frac{1}{2}$  whorls.

Except in external sculpture, this form resembles *V. modesta* from Alaska, figured in Proc. A. N. S. Phila. for 1900, pl. 23, fig. 2. By its sharp striation *V. m. insculpta* is quite distinct from all other large *Vertigos* of the Rocky Mountains, but there is a smaller form of *V. modesta* in Labrador which is striate on the spire.

It is very abundant between 9,000 and 9,500 ft. on Mt. Lemon, in and near the aspen zone, where several hundred specimens were collected.

Very beautiful albino specimens occurred in the colonies from Stations 30, 31, and 37, Mt. Lemon.

Other localities for *V. m. insculpta* are: Santa Catalina Mountains: Soldier Camp. Mt. Lemon at Stations 19, 22, 28, 30, 31, 34, 37, at 8,500 to 9,500 ft.

***Vertigo coloradensis inserta* Pils.**

In the original *V. c. basidens* from Bland, New Mexico, there is one parietal tooth and the basal is at the foot of the columella, remote from the lower palatal. In the Santa Catalina series there is often a small angular lamella, and the basal fold stands close to the lower palatal.

This form replaces *V. c. basidens* in the Canadian zone of the Santa Catalinas. The type is from Bear Wallow.

Santa Catalina Mountains: Desert Laboratory plantation, 8,500 ft.; Bear Wallow Creek, 8,500 ft.; Soldier Camp. Mt. Lemon at Stations 19, 22, 28, 31, 9,000 to 9,500 ft.; Alder Springs. Rincon Mountains at Station 20.

*V. c. inserta* differs from *V. c. arizonensis* by the development of a basal fold, and all of the teeth are larger.

Recent studies of the group have convinced us that *Vertigo columbiana utahensis* Sterki is identical with *V. coloradensis* Ckll. The former name is therefore superfluous. Our record of *V. c. utahensis* from the Chiricahua Mountains, in these *Proceedings* for 1910, p. 144, should be changed to *V. coloradensis*.

**ANCYLIIDÆ**

***Gundlachia californica* Rowell.**

Santa Catalina Mountains: Sabino Canyon, at Alkali Spring, Lowell U. S. Ranger Station, on leaves of *Plantinus wrighti*.

Very few examples are in the *Gundlachia* stage; none were found in the septate stage. Many have the narrow, high, oblique shape of septates, but without septum. Many of them reached the normal size of septates, then had a resting stage during which the shell became blackened, subsequently resuming growth along the margins, forming a narrow, oblique shell somewhat like *A. parallelus* in outline. Other examples become wider, about as in *A. rivularis*, in the second period of growth. The early stages are similar in all, having the usual *Ferrissia* sculpture.

Those individuals in the *Gundlachia* stage do not appear specifically separable from *G. californica*.

#### PHYSIDÆ.

##### *Physa virgata* Gld.

Small specimens which appear to belong to this species were taken in lower Sabino Canyon, with *Gundlachia*.

#### LIST OF COLLECTING STATIONS IN THE SANTA CATALINA, RINCON, TORTILLITA AND GALIUBO MOUNTAINS.

For the Santa Catalinas and Rincons, these stations can be located and approximate elevations ascertained by reference to the U. S. Geological Survey topographic map, Tucson Quadrangle. As different sets of station numbers were unfortunately used in different years, these numbers can only be used in connection with the dates.

##### SANTA CATALINA

*Stations of 1913 (J. H. F.)*

1. Sabino Canyon, bluffs on east side of creek at water gauge dam. Elevation about 4,500 ft.
2. Same, quarter mile farther up.
3. Rock slides near camp at "Picnic Grounds," Sabino Canyon.
4. Slide north of camp, 4,800 ft.
5. Mountain east of camp.
6. About 2 miles along trail to Soldier's Camp. 5,000 ft.
7. Spring near Ranger Station at mouth of Sabino Canyon (*Physa* and *Gundlachia*) 4,500 ft.
8. Mouth of Sabino, foot of bluff, west side. 4,500 ft.
9. Rocks 1 mile above camp.
10. Vantana Canyon at its mouth; a small dry canyon next west of Sabino, not named on topographic map. *Ca.* 4,500 ft.
11. Rock Canyon, in "quartzite" bluff. This is the second small canyon west of Sabino. About 4,500 feet.
12. Vantana Canyon, west side of east mouth. Same elevation.
13. Bear Canyon, east side. 14, same, west side, near 13.
15. Mile above camp in Sabino, on mountain slope, west side. About 5,000 ft.
16. Slide below preceding, about the same elevation.
17. First rocks below Mud Springs, on Pine Canyon (a branch of Sabino above Sabino Basin). Mud Springs are about 9 miles south of Soldier's Camp. About 7,000 ft.
18. Soldier's Camp.

19. Congden Camp.
20. Northeastern side Kellogg Peak.
21. Carnegie Desert Laboratory experiment station, Marshall Pass.
22. Ridge running down east side Lemon Mountain.
23. Ridge running south from Soldier's Camp towards Mud Springs.
24. West side of Marble Peak ridge.
25. Top of same ridge.
26. "Quartzite" slide south side of Marble Peak (same as Station 3, 1910; Station 4, 1910, is the top of same slide).
27. Ridge south of Hinkley Camp.
28. Marshy spring on Lemon Mountain trail.
29. Leaning Rock, south side Lemon Mountain.
30. Aspen Gulch, parallel with main trail to Lemon Mountain. 31, quarter mile below 30, where gulch is close to trail. 32, quarter mile farther down. 33, foot of trail at the stream. Little shells very abundant at these stations and the next.
34. Cold Spring.
35. Southeast side of Marble Peak, about Apache Camp and "Joliet Cave."
36. Northwest side Marble Peak near "Old Dan's Cabin."
37. Westfall's mine.
38. North side Marble Peak near the Daley mine.
39. Goodale's house.
40. Alder Spring, Peck Canyon (one of the head branches of Buehman Canyon). Alder Spring is about 12 miles east of Soldier's Camp Ranger Station; Brush Corral Ranger Station is about 8 miles farther down Buehman Canyon.
41. Buehman Canyon: "Quartzite" slide, Sycamore Spring.
42. Buehman Canyon: Forest Ranger pasture near lower fence, Brush Corral.
43. Buehman Canyon. Lower on the stream, towards Korn Cobb mine.
44. Buehman Canyon. Near the mine.
45. John Lyon's mountain (east of San Pedro River and Rincon Mountains, north of the Little Dragoon Mountains). The rock is granite, and only *Thysanophora hornii* was found.

*Stations of 1917 (J. H. F.).*

(Santa Catalina Range.)

12. Main fork of Sabino Creek, at camp in Sabino Basin.
13. Head of Bear Creek (*Gundlachia* and *Physa*).
14. Head of Bear Canyon.
15. Northeast corner of Sabino Basin, on trail to Soldier's Camp. Boulder dykes along gulches.
16. Same as Station 12, in slides of mountain facing north.
17. Southwest side of Sabino Basin, big mountain in the "Window Range."
18. Brush Corral, crossing of Peck Canyon, Alder Springs.
19. Limestone mountain in foothills of S. Catalinas, San Pedro slope.

(Rincon Mountains.)

20. North side of the high Rincon peaks.
21. Saddle camp, between Santa Catalinas and Rincons.
22. Ridge west of Spud Rock Ranger Station, in aspens.
23. Drift debris of San Pedro River above Mammoth.

(Galiuro Mountains.)

24. Drift of boulders near southeast gate of the forest reserve pasture.
25. In slides, creek bank, above John Rhodes' ranch house.
26. In slides head of the same gulch as 25.
27. In No. 4 slope in amphitheatre of the mountains on Whitlow ranch, east of Sombrero Peak.
- 28 and 29. Other slides in the same vicinity.
30. On trail two miles south of Copper Creek mining camps.

31. Slide west across gulch from smelter, Copper Creek.
32. On trail to Table Mountain about half way from last station.
33. West of abandoned copper camp, creek running north, east of Table Mountain, in slide east of said creek.
34. Slides in same vicinity.
35. Cliffs, northeast rim of Table Mountain.

(Western slope of Santa Catalina Range.)

36. East side of Pima Canyon.
37. West side of Pima Canyon.
38. Drift debris of Pima Canyon.
39. Fork of the Canada del Oro near the foot of Marble Peak.
43. Northeast of Sutherland's ranch, in the foothills.
44. First large canyon north of Romero Canyon, and south of the Sutherland ranch.
45. About one mile east of Station 44.

(Tortillita Mountains.)

40. West side of Hog Canyon, in basin near cement dam.
41. East side of Hog Canyon, on the mountain top.

#### X—MOUNTAINS OF THE GILA HEADWATERS: THE BLUE AND WHITE MOUNTAINS, ARIZONA, AND THE MOGOLLON MOUNTAINS, NEW MEXICO.

The malacological survey of these ranges, which lie in Graham, Apache and Greenlee counties, Arizona, and Socorro county, New Mexico, was begun by one of us (Ferriss) in 1913, and continued by Ferriss and L. E. Daniels in 1914. In 1900 Dr. E. O. Wooten, well known for his work on New Mexican botany, made a ten-day trip in the Mogollons, in course of which he crossed the range from Willow Creek to Mogollon and ascended the eastern flank of Mogollon Peak to almost 9,000 feet. The type of *Ashmunella mogollonensis* was collected on this occasion. So far as we know, no other mollusks had been taken in the region of the Gila headwaters prior to the collections here described.

A few mollusks collected between the San Pedro River and Clifton, Arizona, are included, as they are geographically intermediate between the regions considered in articles IX and X.

Early in September, 1913, Ferriss left Tucson with Frank Cole, the guide of tourists and naturalists, for Mt. Thomas in southern Apache county, 11,496 feet above sea level. Traveling by wagon, brief stops were made in the Graham Mountains and upper end of the Peloncillo range. At Clifton the wagon was stored, saddle horses and pack mules secured, and the trail followed to Metcalf.

From Clifton to the Double Circle ranch on Eagle Creek it is rough country, mostly forested, and with sufficient rock for snail cover, but the snails do not like it. The trail here ran northwesterly

for about 35 miles, then directly north 16 miles on Eagle Creek to the southern rim of the Blue Mountains. Pupas and Vallonias were found at Honeymoon Ranger Station, and *Oreohelix* a mile or two farther on, fifty miles from Clifton.

The rim of the Blue has a wall of broken granite. We found *Ashmunella mogollonensis* and a grayish form of *Oreohelix cooperi*, the latter also in the quaking asp and cork-bark fir groves of the vicinity.

The route lay northwesterly again, across the K. P. *cienaga*, down Corduroy and Fish Creeks and across Black River, to Reservation Creek in Apache Co. This high plateau has a continuous forest of the largest yellow pine, blue spruce, Douglas spruce, thickets of quaking asp and alder. Pupæ and *Oreohelix* were the principal snails. Few were found on the dome-like summit of Mt. Thomas.

Along Black river *Oreohelices*, from pale to nearly black, from high to low, were in every rock pile.

On the return trip the Raspberry trail from the rim of the Blue Mountain to Cosper's ranch on the Blue river was taken. Down the Blue and San Francisco rivers *Ashmunella*, *Sonorella* and *Oreohelix* were found in the slides investigated, but the journey was a hurried one. This ground was thoroughly covered in the journey of 1914.

An account of the journey of 1913 may be found in *Nautilus* for January, 1919.

On the expedition of 1914, Ferriss was accompanied by Mr. L. E. Daniels.<sup>5</sup> Part of the route taken in 1913 was retraced—from Clifton, Graham Co., Arizona, up the San Francisco and Blue Rivers to Cosper's ranch, a distance of about 50 miles. From this point they continued up the Blue River, northeast, to its head, and to Luna, Socorro Co., New Mexico. From Luna the party turned southeast, across the San Francisco Mountains (which lie south of Luna), and by way of Alma to the Mogollon Mountains. Some account of this trip was given in *Nautilus* XXVIII, February, 1915, pp. 109–113. The Ashmunellas collected were described and figured in *Nautilus* XXIX, June, July and August, 1915, to which the reader is referred for these matters. A map showing the collecting stations in the Mogollons may be found on page 331.

<sup>5</sup> We have to record the death of Mr. Daniels, October 23, 1918. He was a companion of both authors on collecting trips of some months' duration, and it is a real sorrow that he will no longer share the labors of the trail or the cheer of the evening camp fire.

The San Francisco and the Blue rivers have been seriously torn up by floods in recent years, but many of the snails remain. Nearly all the farmers have been swept out. *Oreohelices*, *Sonorellas* or *Ashmunellas* exist in every favorable situation from Clifton to Bob Cat on the interstate boundary, except in a few short stretches of these rivers where the snails seem to have a dislike for the soil, the chemistry of the rocks, or something not traced. This is about fifty miles in a straight line, and thus very long miles.

Again on the Luna road to Alma, in New Mexico, *Oreohelix* was found on the crest of the San Francisco Mountains, and the largest colony, with many albinos, came from the Rio Saliz, a small stream draining the San Francisco Mountains eastward into the San Francisco River.

The Mogollons might be called a federation of sharp peaks. It is not a high plateau like the White and Blue mountain region, yet the forest conditions and tree associations are almost identical. On the Bursam wagon road from Mogollon to Willow Creek, ascending to 9,000 feet, and usually running along the north slope of the peaks, the conditions for snails are ideal. *Ashmunella mogollonensis* and *Oreohelix cooperi* were soon picked whenever logs or stones were turned in this (for snail hunters) two-day journey. At two points *Oreohelix barbata* was found with the other two species. Afterward, when the canyons facing west and south were explored the smaller *Ashmunellas* were found in colonies with the three above mentioned. *Sonorella* has not yet been found in the Mogollon range. In the extreme southern part of Arizona (Chiricahua range) the large toothless *Ashmunellas* are in colonies with the smaller toothed forms and *Oreohelix barbata* with them. Also a *Sonorella* and sometimes *Holsospira*. Three species of *Sonorella* have been found in one slide; but the general Arizona rule still remains one species of the genera of Helices to a colony.

The banks of the canyons running west, in the Mogollons, were abrupt, and the south bank furnished shade and cover. In Big Dry Canyon, running directly south, the banks were so abrupt and close together that snails were living on both sides of the stream, and in the greatest abundance within our experience.

The wide differences in the *Ashmunellas* of the Mogollons and the presence of the Chiricahua *Oreohelix barbata* seem to indicate an alluring future for Mogollon conchology. We believe that the deeper canyons, penetrating farther into the large mountains, had greater riches than Big Dry, lying in between them. Here too in the

canyon streams live the mountain trout, friendly and well conditioned, but they are not the cut-throat trout of the Colorado.

On the whole the Mogollons, in scenery and camping delights, are not far behind the White and Blue Mountain region of eastern Arizona. Silver City is the nearest and most convenient railway station, and moreover it lies in a region unexplored by the snail fraternity.

One more killing was made on the return to Clifton, a colony of Sonorellas at Steeple Rock, Sept. 14. Thus this event of 1914 had a continuous run of two months and seven days.

Aside from the minute Canadian Zone snails which have a wide distribution at high levels, and the minutiae of the desert foothills such as *Thysanophora hornii*, *Succinea avara*, the small *Zonitoides*, etc., there are several forms showing close affinity between the San Francisco-Mogollon region and the Chiricahua Range. The species *Sonorella binneyi*, *Ashmunella chiricahuana* and *Orohelix barbata* of the Chiricahuas are represented here by *S. binneyi franciscana*, *A. mogollonensis* and *O. barbata*. The toothed Ashmunellas are of nearly related species, and the same group of forms extends farther east in New Mexico to the Black Range. None of the species mentioned are found in the northern or Dos Cabezas part of the Chiricahua range, their habitats being from 80 to over 100 miles south of the regions now under consideration. The intervening region is at the present time too dry for the existence of these snails.

#### HELICIDÆ.

*Sonorella grahamensis* n. sp. Pl. VI, figs. 7, 7a, 7b.

The shell is umbilicate (the width of umbilicus contained about  $8\frac{1}{2}$  times in the diameter of shell), very thin, tawny-olive, paler at the base, with the usual band; not very glossy; under the lens showing the usual weak growth-lines, and both above and below there are numerous spiral impressed lines. Whorls slowly increasing at first, the last rapidly widening, descending in front. Aperture rounded-oval, quite oblique. Peristome is thin, very little expanded.

Alt. 10, diam. 19 mm.; umbilicus 2.2 mm.;  $4\frac{1}{2}$  whorls.

Genitalia (fig. 9). The penis has a well developed sheath at the base, and contains a long, tapering papilla. The penial retractor is inserted at the base of epiphallus and apex of penis as in the *hachitana* group. There is a short flagellum. The organs measure:

Length of penis 9 mm.; papilla 7; epiphallus 6; flagellum 0.5; penial retractor 4.7; vagina 7; spermatheca and duct 19 mm.



Fig. 9. Genitalia of *S. grahamensis*, with two details of the penis-papilla. Type specimen.

Mt. Graham, in the Pinaleno Range, Graham Co., Arizona, type No. 109,101 A. N. S. P., collected by J. H. Ferriss, 10-14-1913.

Graham Mountain is composed of crumbling granite (similar to that of Nine-mile Water Hole in the Dos Cabezas range), and is very dry on both north and south sides. On top there is yellow pine and quaking asp forest. Camp was made in Stockton Pass, and a couple of hours' collecting done at Mud Spring, on the summit. Besides *Sonorella* and *Oreohelix*, *Vitrina alaskana* was abundant, and two young Vallonias were found. The Pinaleno Range lies in line with the Chiricahua system, though separated by a rather wide mesa, in which the Southern Pacific R. R. runs, from the northern end of the Dos Cabezas Mountains.

*S. grahamensis* is not closely related to any other species known to us. The delicate, spirally striate shell and the rather fusiform penis-papilla are characteristic.

***Micrarionta praesidii* n. sp. Pl. VI, figs. 8, 8a, 8b.**

The shell is depressed, umbilicate (the width of umbilicus contained about 5.7 times in the diameter), thin. The "dead" shell is grayish white above, pale ecru-drab below, with some radial white streaks, and at the shoulder a narrow, faintly traced gray band which becomes cinnamon towards the aperture. Under a lens fine gray spiral lines are seen in places on the base. The initial half whorl is smooth;

next whorl has hyphen-like tubercles parallel with the suture, not closely placed; subsequent whorls have faint growth-lines only; there is no trace of spiral striae.

The whorls are rather strongly convex, at first slowly increasing, the last very wide, rather deeply descending in front. The aperture is strongly oblique, nearly circular, faintly washed with ochraceous within. The peristome is sharp, very little expanded except at the columellar insertion where it is broadly dilated; terminations connected by a rather long, quite thin parietal callus.

Alt. 8.5, diam. 16 mm.; umbilicus 2.8 mm.;  $4\frac{1}{2}$  whorls.

Fort Grant, at foot of the Graham Range, Graham Co., Arizona, the type, No. 58,121 A. N. S. P., collected by Dr. George H. Horn.

By the sculpture of the embryonic shell, as well as the general appearance, this snail resembles *Micrarionta hutsoni* Clapp, which is smaller, more depressed, with a larger umbilicus. It is somewhat intermediate in form, between *hutsoni* and *indioensis*. If it really belongs to *Micrarionta*, and there is no mistake about the locality, it is widely separated from its congeners.

The single specimen has been in the collection for many years. It had been labelled *H. strigosa* Gld.

Dr. Horn, the distinguished coleopterist, was stationed at Fort Grant sometime after 1863. He collected a number of shells in that vicinity, which were described by W. M. Gabb in the American Journal of Conchology for October, 1866, pp. 330, 331, as follows:

*Helix hornii* Gabb. [*Thysanophora hornii*].

*H. strigosa* Gld. "The largest specimen I have seen of the species" [= *Sonorella* sp. undet.].

*H. minuscula* [*Zonitoides minuscula alachuana*].

*Pupa (Modicella) arizonensis* Gabb [= *Pupoidea marginata* var.].

*Pupa hordacea* Gabb [*Pupoidea hordacea*].

The locality is given as "Fort Grant, at the junction of the Arivapa and San Pedro Rivers," but that junction is really a long day's travel—fully fifty miles—westward; yet it may have been the nearest definite landmark to be found on maps of the time.

The "*H. strigosa*" mentioned by Gabb is a *Sonorella* 25 mm. in diameter, of the *S. hachitana* group. The upper part of the peristome is broken away, and the shell is bleached; we do not recognize the species.

Of the *Zonitoides* several live specimens are preserved. They probably came from around a spring. All of the other shells mentioned are such as live among rocks in arid foothills. The speci-

men of *Pupa hordacea* seems to have been given to Mr. Binney; the other species taken by Dr. Horn are in the collection of the Academy.

As Dr. Horn was also at Gila Bend, Yuma and other places in western Arizona, the possibility of an erroneous locality label for the specimen of *M. praesidii* is to be considered. That specimen was not mentioned in Gabb's paper, but he would doubtless have considered it a small "*H. strigosa*".

**Sonorella rooseveltiana** (Berry). Pl. VI, figs. 9, 9a, 9b.

Nautilus XXXI, July, 1917, p. 14.

Roosevelt, Gila Co., Arizona, 2200 ft. elevation. Figures of the type, supplied by Dr. Berry, are here given for comparison with the forms of adjacent counties. They are 1.6 natural size, the diameter being 16.5 mm.

*S. rooseveltiana* appears to belong to the *hachitana* group, but the single specimen dissected was quite immature. It is, we believe, the only mollusk reported from Gila County.

**Sonorella delicata** n. sp. Pl. VI, figs. 6, 6a, 6b.

The shell is umbilicate (umbilicus contained slightly over 6 times in diameter of shell), thin, somewhat translucent, light ochraceous-buff with several pale or whitish oblique streaks on the last whorl, and a cinnamon-brown band above the periphery. Glossy, having the usual weak irregular growth-lines. The embryonic whorls are nearly smooth, but short, protractive threads may be seen near the suture.

The last whorl is wide and descends rather slowly in front. The aperture is strongly oblique, rounded-oval. Peristome thin, expanded, with a dull brown edge.

Alt. 10.5, diam. 18.3 mm.;  $4\frac{1}{2}$  whorls.

Genitalia (fig. 10) remarkable for the small size of the male organs. The length of penis is about one-fifth the diameter of the shell, very slender, having a stout basal sheath, and containing a short, cylindric papilla. The epiphallus is longer than the penis, terminating in a short flagellum.

|                 |         |
|-----------------|---------|
| Length of penis | 3.5 mm. |
| papilla         | 1.2 "   |
| epiphallus      | 4.5 "   |
| flagellum       | 0.4 "   |
| vagina          | 5.5 "   |

Northern end of the Peloncillo Range, about 6 miles south of the Gila River, on the toll road between Solomonsville and Clifton,

Graham Co., Arizona; in a "malpais" rock slide, about 4,800 ft. elevation, type No. 109,110 A. N. S. P. paratypes in Ferriss Coll.; collected by J. H. Ferriss, 11-14-1913.

The shell recalls *S. bowiensis* Pils., differing by the wider last whorl, smaller aperture and somewhat smaller umbilicus; also much less distinct sculpture of the embryonic whorls. The genitalia, examined in several individuals, differ by the very small size of the male organs, relatively even smaller than in *S. hachitana* and its

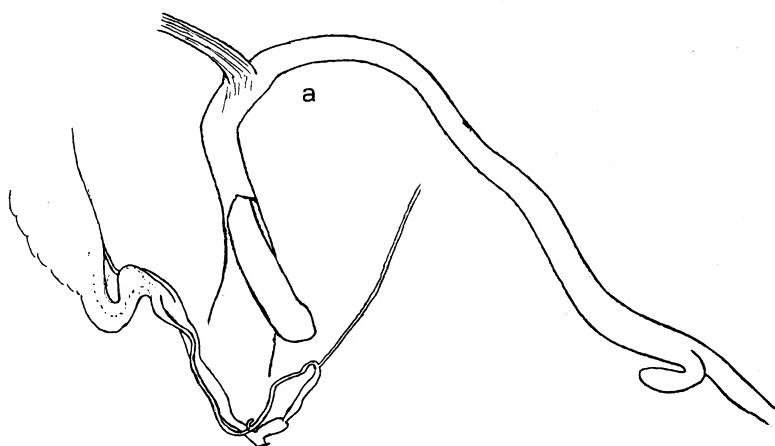


Fig. 10. Genitalia of *S. delicata*. *a*, outline of penis-papilla, epiphallus and flagellum.

immediate relatives. It differs from these by the cylindric penis-papilla with bluntly conic end. The genitalia of *S. walkeri* P. & F., of the Santa Ritas, have considerable similarity.

The living animal has an odor like *S. odorata* in the Santa Catalinas.

**Sonorella cærulifluminis n. sp.** Pl. VI, figs. 1 to 4.

The shell is depressed, umbilicate, the umbilicus contained about 8 times in the total diameter, somewhat translucent, nearly isabella color, having a chestnut-brown band at the shoulder, showing above the suture on the penult and usually half of the next earlier whorl, and without white bordering bands, though the shell may be slightly paler there. It is somewhat translucent throughout. Surface glossy. Embryonic portion of  $1\frac{1}{2}$  whorls, at first with some radial ripples, then irregularly pitted-granulose, with weak oblique threads as in others of the *S. hachitana* group. First post-embryonic whorl is weakly striate and minutely papillose; later whorls with sculpture of delicate, irregular growth-lines only. The whorls are moderately

convex, the last descending slowly in front. The aperture is rounded oval-lunate, large. Peristome expands a little and is dilated at the columellar insertion.

Alt. 14.6, diam. 25 mm.; alt. of aperture 12.3, width 14.3 mm.;  $4\frac{1}{2}$  whorls (type, Station 18).

Blue and San Francisco Rivers, Graham Co., Arizona, the type (No. 119,048 A. N. S. P.) from Station 18 (1914), San Francisco River 6 miles above its confluence with the Blue River. Found also at Stations 5, 8, 10, 15, 16, 17, 19, 20 (1914), and 89, 91 (1913); from Ash Canyon, 6 miles above Clifton, to the mouth of Sardine Creek on the Blue River. The higher of these colonies are at little more than 4,000 ft.

While closely related to *S. hachitana*, it differs from that by the absence of white bands bordering the shoulder-band, and of a white umbilical area, by the suture descending less deeply and not so abruptly in front, and by the smooth penis-papilla.

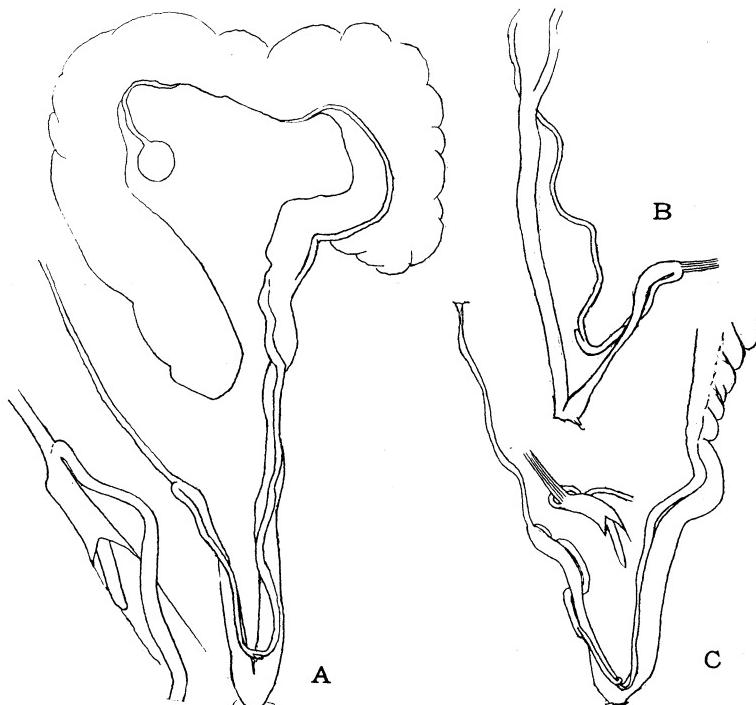


Fig. 11. Genitalia of *Sonorella cærulifluminis*. *a*, No. 119,048, Station 18, typical, with enlarged detail of penis-papilla; *b*, No. 119,042, Station 19; *c*, Station 16, No. 119,046.

The head and back are blackish brown, fading downward and backward to dark grayish brown, the tail paler. The sole has lateral bands somewhat darker than the central field (No. 119,048).

Genitalia (fig. 11) generally similar to *S. hachitana*. The penis is very slender, its retractor muscle longer; penis-papilla slender, smooth, with tapering end. A short flagellum is present. The epiphallus is nearly as long as the penis. The vagina is generally longer than the penis.

In one specimen dissected, Station 20 (fig. 12a), the penis is about a third longer, its *papilla very long*, three times the usual length or more. The flagellum also is much longer. Such differences would usually be thought specific, yet I have not found any differences in the shells from this locality.

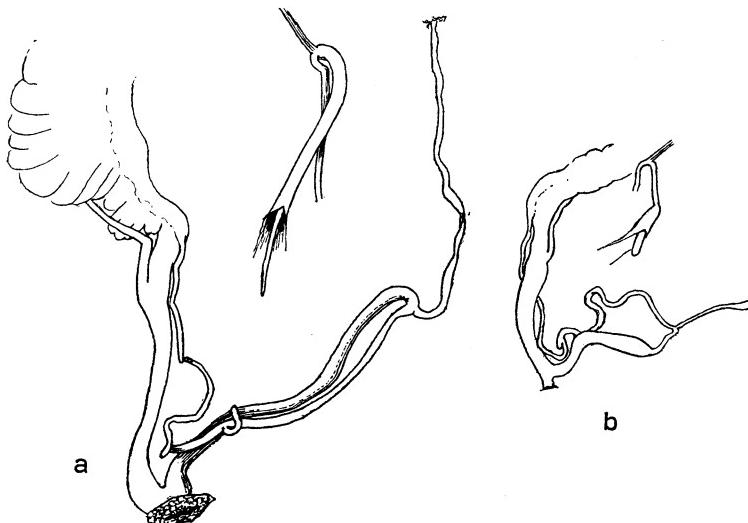


Fig. 12. a, Genitalia of *S. caeruleifluminis* var., 119,047, from Station 20, Blue River. b, *S. binneyi franciscana* No. 119,044.

#### Measurements of genitalia of *S. caeruleifluminis*.

| Collecting Station . . . . . | 18      | 19      | 16      | 20      |
|------------------------------|---------|---------|---------|---------|
| Penis . . . . .              | 8.5     | 7.5     | 7       | 12      |
| Penis-papilla . . . . .      | 3       | 3.5     | 4       | 11      |
| Epiphallus . . . . .         | 8       | 6       | 7       | 8.7     |
| Flagellum . . . . .          | 0.6     | 0.7     | 0.5     | 2       |
| Retractor . . . . .          | ..      | ..      | 10      | 13      |
| Vagina . . . . .             | 15      | 14      | 8       | 9.5     |
| Museum No. . . . .           | 119,048 | 119,042 | 119,046 | 119,047 |

The size of the shell is rather variable, the extremes of diameter in a series from Station 17 being 20 and 24.6 mm. The largest specimen noticed measures 26.4 mm. An individual without a dark band is photographed in fig. 4. It is from Station 19, Blue River, at the mouth of Pigeon Creek. Two other shells from this station are illustrated in figs. 2, 2a and 3, 3a.

**Sonorella binneyi franciscana** n. subsp. Pl. VI, figs. 5, 5a, 5b.

The shell is umbilicate (width of umbilicus contained 9 to 10 times in that of shell), light pinkish cinnamon with some paler or white oblique streaks and indistinctly paler on both sides of a chestnut-brown band above the periphery. This band shows above the suture of the last half of the penult whorl. The surface is glossy; embryonic shell of about  $1\frac{1}{2}$  whorls, the first half having some radial ripples, the next whorl minutely granulate, having oblique, curved threads, protractive below, retractive above; the later whorls with fine, unequal growth-lines. The whorls are convex, slowly increasing at first, the last rapidly widening, descending a little in front. The aperture is unusually large, shortly oval-lunate. The peristome is very narrowly expanded, straightened and dilated towards the columellar insertion.

Alt. 11.6, diam. 19mm., aperture 9.8x11.5 mm.;  $4\frac{1}{2}$  whorls.

San Francisco River, Graham Co., Arizona; type locality, Station 92 (1913), above Sardine Creek. Also taken at Station 93 in the same vicinity, and at Station 13 (1914), 2 miles above Harper's. Ferriss and Daniels.

The head and back are dark grayish brown shading into dark vinaceous drab downward and backward, the tail light colored.

Genitalia (Fig. 12b). The penis contains a cylindric papilla with blunt, rounded end. The epiphallus is about twice as long as the penis, and bears a small flagellum. The *penial retractor* inserts on the epiphallus some distance (over  $\frac{3}{4}$  mm.) above the penis. The vagina is nearly or about as long as the penis. Measurements follow:

|                       |         |         |         |
|-----------------------|---------|---------|---------|
| Station.....          | 13      | 13      | 93      |
| Length of penis ..... | 5       | 6       | 7 mm.   |
| papilla .....         | 2       | 2.3     | 3.5 "   |
| epiphallus .....      | 10.5    | 10      | 10.5 "  |
| flagellum .....       | 0.5     | 0.7     | small   |
| penial retractor..... | 3.3     | ..      | ..      |
| vagina.....           | 4.7     | 5       | 5.5 mm. |
| Museum No.....        | 119,044 | 119,044 | 109,413 |

By its genitalia and shell this subspecies is closely related to *S.*

*binneyi* P. & F., of the southern Chiricahuas. The blunt penis-papilla, and especially the insertion of the penial retractor on the epiphallus some distance beyond the apex of the penis, are alike in both. There are, however, some differences in the proportions of the organs, the epiphallus and penis-papilla being longer relative to the penis in *S. b. franciscana*, and the last whorl of *franciscana* is a little wider, viewed from above.

The diameter, in specimens seen, is from 17 to 19.3 mm.

**Ashmunella pilsbryana** Ferriss.

*Ashmunella pilsbryana* Ferriss, Nautilus XXVII, 1914, p. 109.

*Ashmunella pilsbryana* Ferriss & Pilsbry, Nautilus XXIX, 1915, p. 42, pl. 2, fig. 3.

Arizona: Along the San Francisco River, from near Harper's Ranch to 2 miles above the mouth of the Blue River, Graham and Greenlee Counties, Arizona.

**Ashmunella mogollonensis** (Pils.).

*Ashmunella chiricahuana mogollonensis* Pilsbry, Proc. A. N. S. Phila., 1905, p. 252, pl. 16, figs. 101, 102.

*Ashmunella mogollonensis* PILSBRY, Nautilus XXIX, 1915, p. 42. PILSBRY & FERRISS, Proc. A. N. S. Phila., 1917, p. 93, pl. 7, fig. 10 (shell), and pl. 10, fig. 3 (genitalia).

Professor E. O. Wooten, who discovered this snail, crossed the Mogollon Range from Willow to Silver Creeks, along what is now called the Bursam road. He also made an excursion from the West Fork of the Gila towards Mogollon Peak, reaching a point about  $1\frac{1}{2}$  miles due east of the Peak, in the forks of Whitewater Creek, at about 9,000 ft. It was probably here that he obtained the type of *A. mogollonensis*, though it is also common along Silver Creek and the Bursam Road.

Specimens were taken along Silver Creek and the Bursam Road at Stations 38, 42, 43, 44, 45, from about 7,500 to 9,000 ft. elevation, and at Station 46, Little Turkey Creek, at about 9,000 ft.

It is rather variable in size, specimens from Station 38 measuring from 16.5 to 21 mm. diameter, those from Station 46 from 17 to 19 mm. Other localities in the Mogollons are Station 51, head of Mineral Creek, where there are some beautiful albino shells, and 70, 76, 79, on Dry Creek, the shells mostly large.

In Arizona it was taken in 1913 at Stations 59, 84, 86, all on or near the rim of the Blue Mountains, at 5,500 to 12,000 feet. The shells average larger than in the Mogollons, very few being under 20 mm. in diameter. Specimens from Station 59 measure:

Alt. 11.5 diam. 22.8 mm.  $5\frac{3}{4}$  whorls.

" 11 " 21 "  $5\frac{3}{4}$  "

" 8.5 " 18.3 "  $5\frac{1}{3}$  "

Extremes of size, Station 86.

Alt. 11 diam. 22.8 mm.  $5\frac{3}{4}$  whorls.

" 10 " 19.5 "  $5\frac{3}{4}$  "

*A. mogollonensis* differs from *A. chiricahuana* by the very small and short penis, scarcely differentiated from the epiphallus; the absence of a penial retractor muscle; and the more capacious spermatheca, which is sacculate distally in some individuals. There are also differences in the proportions of the organs, but whether constant or not can be determined only by measuring a long series. In both the epiphallus is very long. The shells can be distinguished by the minute but deeply engraved spiral-lines of *A. mogollonensis*.

Other species of *Ashmunella* from the Mogollon Mountains were described in *Nautilus* XXIX, 1915, as follows:

*Ashmunella tetrodon* Pils. & Ferr. Dry Creek.

*Ashmunella tetrodon mutator* Pils. & Ferr. Dry Creek.

*Ashmunella tetrodon inermis* Pils. & Ferr. Dry Creek.

*Ashmunella danielsi* Pils. & Ferr. Cave Spring Canyon.

*Ashmunella danielsi dispar* Pils. & Ferr. Little Whitewater Creek.

**Oreohelix cooperi** (W. G. B.). Pl. VII, figs. 1 to 6a.

Mogollon Mountains, Socorro Co., New Mexico: Willow Creek, Stations 46-48, at from about 8,300 to nearly 9,000 ft.; Silver Creek and along the Bursam Road (above Mogollon), at about 7,500 to 9,000 ft., Stations 39, 40, 42,  $42\frac{1}{2}$ , 43, 44; also Station 35.

The specimens from these localities closely resemble those figured by us from the Black Range, N. M. (in these *Proceedings* for 1917, pl. 9, figs. 5-9), but there is greater variation in contour, as in pl. VII, figs. 6, 6a from Station  $42\frac{1}{2}$ , near the crest of the range, measuring

Alt. 13, diam. 21 mm.

" 16.5, " 20 "

The commonest form is like that shown in pl. 9, fig. 7 of our paper of 1917; the size generally from 21 to 23 mm. diam. A large shell from Station 48 measures, alt. 16.4, diam. 23.3 mm. At Stations 39 and 40 they are smaller, diam. 18 to 20 mm. The size is independent of elevation, as there are larger shells both above and below these stations in the Willow Creek region.

In Arizona the same "Black Range form" of *cooperi* was found on the southern slope of the Blue Mountains, Station 59 (1913),

in Cosper's pasture, Station 58 (pl. VII, fig. 1) and farther northward in the southern part of Apache Co., on Mt. Thomas, White Mountains, at Station 75 (1913). In all of these stations there are the same capacious whorls and frequently very high spire noted in the Mogollons.

All of the preceding inhabit high elevations, and all were found under logs and leaves in heavy timber, as in the Black Range of New Mexico. The following lots were all among rocks (pl. VII, figs. 2-5b).

Farther down the Blue River (in Greenlee Co., Arizona), the species was found as far as Station 23, east side of the river 2 miles above the mouth of Grant Creek (pl. VII, figs. 5-5b). While there is abundant intergradation with the shells of higher elevations just noticed, the majority of the shells are more openly umbilicate. Many have the spire very high, but this is variable in all the lots. Three examples from Station 23 figured measure:

|          |       |           |           |         |
|----------|-------|-----------|-----------|---------|
| Alt. 16, | diam. | 26.5 mm., | umbilicus | 4.7 mm. |
| " 18,    | " 24  | " "       | 4.5       | "       |
| " 17.8   | " 23  | " "       | 3         | "       |

The shells from Station 25 are almost as large; those from Stations 26 to 32 (going up the river) are smaller. Specimens from Station 29, 1 mile above Blue River Ranger Station (pl. VII, figs. 2-2b) measure:

|          |        |          |
|----------|--------|----------|
| Alt. 17, | diam.  | 22.3 mm. |
| " 18     | " 22.2 | "        |
| " 15     | " 22   | "        |
| " 15.6,  | " 18   | "        |



Fig. 13. *Oreohelix cooperi*, albino, Station 29.

There are some beautiful albino specimens in this lot (fig. 13). Other examples are figured (pl. VII, figs. 3, 3a) from Station 27, near the Blue River Ranger Station, where the shells are very dark colored. One measures, alt. 13, diam. 20.5, umbilicus 5 mm.

A series from Station 36, Mt. Lisa, Lisa Creek, Socorro Co., N. M., 20 miles north of Alma, is similar to those of Station 29, also with not a few albino shells.

The Blue River series shows all gradations of shape between very high shells, those of the typical *cooperi* contour, and an openly umbilicate shell with whorls of small caliber. The sculpture varies from that of Black Range *cooperi* to more effaced, the striation and spirals weak.

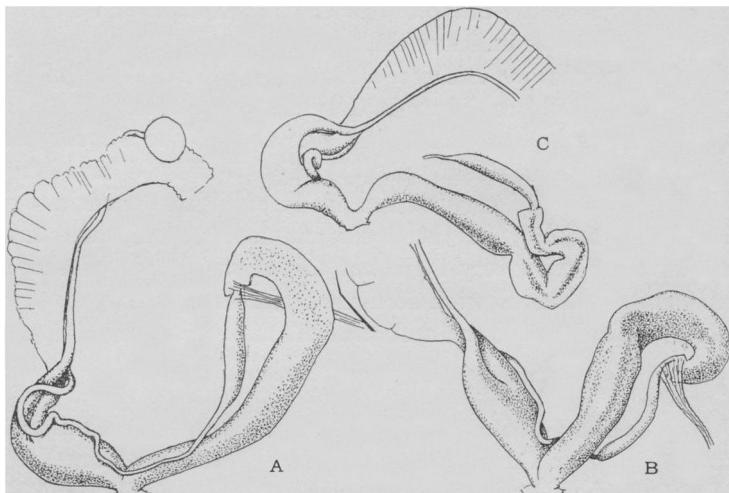


Fig. 14. Genitalia of *Oreohelix cooperi*. a, Cosper's pasture; b, Blue River, Station 26; c, form *apache*, Black River, Station 81.

The genitalia (figs. 14a, b, c) agree with those organs in *O. cooperi* from the Black Range, N. M., figured in these *Proceedings* for 1917, p. 101, fig. 5. The internally ribbed portion of the penis forms more than half of the total length of that organ, as in all forms of *O. cooperi*. Measurements in mm. follow. Numerous other specimens opened but not measured were seen to agree with those illustrated. They are distinguishable at sight from all forms of *O. strigosa*.

| Station.   | Penis. | Internally<br>ribbed part<br>of penis. | Epiphallus. | Vagina. | Diam. of<br>Shell. | Museum<br>No. |
|------------|--------|--|-------------|---------|--------------------|---------------|
| 26 (1914). | 16     | 9                                      | 6           | 6       | 23                 | 119,151       |
| 58 (1913). | 17     | 10                                     | 7           | 5       | 21                 | 109,173       |
| 35 (1914). | 13     | 7.5                                    | ...         | ...     | 20                 | 119,152       |
| 36 (1914). | 13     | 8                                      | ...         | ...     | 21                 | 119,153       |
| 23 (1914). | 18     | 10                                     | ...         | 7       | 24                 | 119,150       |
| 76 (1913). | 19     | 10.5                                   | 6           | ...     | 23                 | 109,184       |
| 81 (1913). | 18     | 9.5                                    | ...         | 4.5     | 23                 | 109,180       |
| 81 (1913). | 17.5   | 8                                      | 6.3         | ...     | ...                | 109,180       |

Preparations are figured from Stations 26, Blue River (fig. 14b), 58, Cosper's pasture (fig. 14a) and 81, Black River (fig. 14c). The specimen dissected from Station 36 is an albino.

*O. cooperi* form *apache*, new form (pl. VII, figs. 7 to 8a). Rather large size, dark or very dark coloring and subobsolete sculpture (the spirals being especially weak) characterize the shells taken along the Black River and Fish Creek, in Apache County, Arizona. The shell is generally quite depressed and as openly umbilicate as the forms of *O. strigosa*. The diameter is usually from 22 to 26 mm. Few have the spire very high, and none are as high as many of the Blue River shells.

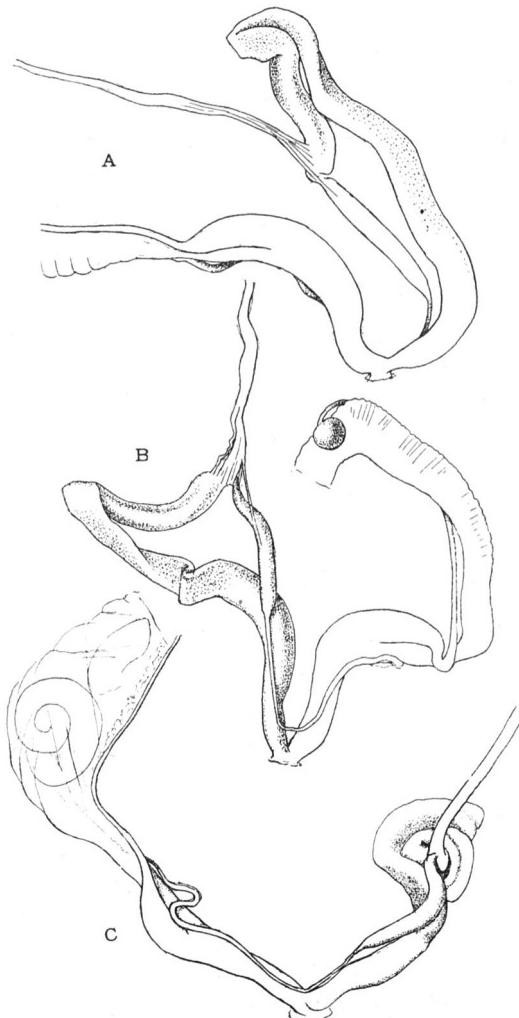


Fig. 15. Reproductive organs of *Oreohelix strigosa meridionalis*, the middle figure drawn from the type specimen.

Alt. 15, diam. 24 mm., umbilicus 4.5 mm.

Type No. 109,184, from Station 76 (1913), Black River 2 miles above Fish Creek. It was taken also at Stations 53, 60-62, 64, 66, 68, 69, 71, 72, 76-81, 83 of the expedition of 1913.

On account of the form and sculpture of this large series, so unlike the usual forms of *cooperi*, it appears best to name it. The Blue River series varies from the *apache* type to the normal *cooperi* form. Indeed, specimens could be selected from the Mogollon series agreeing with *apache*, though they are quite exceptional there. The genitalia are either practically typical *cooperi*, as at Station 76, or the costate part of the penis may be relatively a trifle longer, as at Station 81 (fig. 14c).

**Oreohelix strigosa meridionalis** n. subsp. Pl. VII, fig. 9.

The shell is depressed and very openly umbilicate, the last whorl subangular above the aperture; otherwise resembling *O. c. apache*. Striation weak, subobsolete spiral lines only very faintly developed.

Alt. 14.4, diam. 24.5 mm.; umbilicus 6 mm. wide;  $5\frac{1}{2}$  whorls.

Y Salt House branch of Eagle Creek, Graham Co., Arizona; type No. 109,186 A. N. S. P. Also taken on the Black River near the horseshoe bend.

By the shells alone we would hardly separate this form from *O. cooperi apache*; yet the genitalia were found to be like *O. s. depressa*.

The genitalia (fig. 15) agree with those of *O. s. depressa* and various allied forms except that the organs are longer in shells of similar diameter; yet in Colorado *depressa* this is a rather variable character, and it is somewhat affected by the conditions of preservation. The penis is very long, its internally costate portion hardly one-third of the entire length, having about 4 principal ribs within; the internally papillose portion flattened, weakly ribbed within, sometimes having a trilobed section distally. Measurements of the organs in mm. follow:

| Station<br>(1913). | Penis. | Internally<br>costate<br>portion. | Epi-<br>phallus. | Vagina. | Diameter<br>of shell. | Fig.  | Museum<br>No. |
|--------------------|--------|-----------------------------------|------------------|---------|-----------------------|-------|---------------|
| 56                 | 33     | 9                                 | 10               | 9       | 24                    | 15b   | 109,186       |
| .....              | 31     | 10                                | 8                | 10      | .....                 | 15a   | 109,177       |
| 71                 | 19.5   | 6                                 | 5                | 6.5     | 22                    | ..... | 109,179       |
| .....              | 28     | 7.5                               | 6                | 8       | 21.5                  | 15c   | 109,190       |

*O. s. meridionalis* differs from *O. s. depressa* by the distinctly smoother shell.

**Oreohelix barbata** Pils.

The occurrence of this species in the Mogollons was a surprise, as it was described from the Cave Creek region of the Chiricahuas, far to the south. It does not inhabit the dryer northern half of the Chiricahua range, and its distribution is therefore conspicuously discontinuous. It evidently changes much more slowly than the Ashmunellas, though some little differentiation may be seen as noted below.

In *Dry Creek*, it was taken in the slides with *Ashmunella*, at Stations 62, 64, 68, 70, 72, 75, 77, 78 and 79. In most of these colonies it reaches large size, even larger than in the Chiricahuas. Two examples from Station 79 measure: height 8, diam. 16 mm., and height 9, diam. 15.4 mm. Usually there are several circular fringes on the last whorl above the periphery, and more on the base than in Chiricahua examples. In the latter, fringes above are exceptional. Counting that at the periphery, there are usually 8 to 11 spiral wreaths in *Dry Creek barbata*, 6 to 10 in Chiricahuan specimens. In some lots the cuticular appendages are mostly or quite lost in the adult stage. Some consist partly of smaller individuals; and at Stations 64 and 75 all are small, 11-12 mm. in diameter.

*Cave Spring Canyon*, Station 57. Very small, about 10 mm. diameter, and agreeing well with *O. b. minima* P. & F. (Proc. A. N. S. Phila. 1910, p. 94, fig. 15) from Rucker Canyon, Chiricahuas. There is probably no direct relationship, each being presumably a diminutive race of the normal larger forms of their respective ranges. These small forms show decadence by the deep descent of the last whorl to the aperture.

*Willow Creek*, Station 46. This is on the eastern slope of the Mogollon watershed. The size is small, diameter about 11 mm. Cuticular appendages usually deciduous.

**Thysanophora hornii** (Gabb).

Arizona: Station 45 (1913), John Lyon's Mountain, north of the Little Dragoons. Blue River, Station 18 (1914), and Little Blue River, Greenlee Co.

New Mexico: Station 76, Dry Creek, west side of the Mogollon Mountains.

**Thysanophora ingersolli** (Bld.).

Arizona: Reservation Creek, 9,500 ft.; Fish Creek; Horseshoe bend of Black River, and 2 miles above, at 9-10,000 ft. Apache Co. Cosper's pasture, Graham Co.

New Mexico: Stations 38, 42, 45, 51, 57 in the Mogollon Mountains, abundant.

#### **ENDODONTIDÆ.**

##### **Gonyodiscus cronkhitei (Nc.).**

Arizona: Cosper's pasture, 11,000 ft., and rim of the Blue Mountains, 12,000 ft., Graham Co.; Blue River, Station 29 (1914), Greenlee Co. White Mountain Camp at Mt. Thomas, 13,500 ft., Apache Co.

New Mexico: Stations 36, 42, 45, 46, 57 in the Mogollon Mountains, abundant.

##### **Radiodiscus millecostatus Pils. & Ferr.**

Arizona: Little Blue River, Greenlee Co.; Cosper's pasture and Station 59, head of "hot air trail" rim of Blue Mountains, 12,000 ft., Graham Co.; Reservation Creek, Apache Co.

New Mexico: Station 45, Willow Creek, Mogollon Mountains.

##### **Helicodiscus arizonensis (P. & F.).**

Arizona: Cosper's ranch, on the Blue River, 5,060 ft.

New Mexico: Stations 36, 42, 55, 57, Mogollon Mountains.

##### **Punctum conspectum (Bld.).**

Arizona: Station 75 (1913), Thomas Peak, Apache Co.

New Mexico: Willow Creek, Mogollon Mountains, at Station 45 (1914).

These shells appear to be somewhat more glossy than the Californians compared, the spiral striation better developed, and the ripples irregularly developed; yet we would hesitate to separate the specimens from this widely spread west coast species.<sup>6</sup>

##### **Punctum pygmaeum (Drap.).**

Arizona: Station 70 (1913), Black River near the Horseshoe bend; somewhat abundant. This is the first record of the species for Arizona.

#### **ZONITIDÆ.**

##### **Polita hammonis electrina (Gld.).**

Arizona: Station 80 (1913), Black River. One example. There are no spiral striae.

##### **Polita indentata umbilicata (Ckil.).**

Arizona: Blue River at Cosper's ranch, 5,060 ft., and Stations

<sup>6</sup> A form of this species was collected in great numbers about bushes in a meadow at the west end of Oswego, Clackamas Co., Oregon, by Mr. John A. Allen in 1913 and 1914. It differs from typical *P. conspectum* by the larger size and decidedly higher, conic spire, and may be called *Punctum conspectum allenii*. The type measures, alt. 1.7, diam. 2.3 mm. (No. 111,413 a, A. N. S. P.). A specimen of *P. conspectum* received from Bland measures, alt. 1.25, diam. 2.1 mm.—H. A. P.

18, 29 (1914); Little Blue; rim of Blue Mountains, 12,000 ft.; also in Apache Co. on Fish Creek, 10,500 ft.

New Mexico: Stations 38, 42, 46, 55, Mogollon Mountains.

**Striatura milium meridionalis** (P. & F.).

Arizona: Cosper's pasture, 11,000 ft., Graham Co.; Black River and Reservation Creek, 9,500 ft., Apache Co.

New Mexico: Station 57, south fork of Whitewater Creek, Mogollon Mountains.

**Zonitoides arborea** (Say).

Arizona: Station 29, Blue River; Cosper's pasture and rim of the Blue Mountains, Graham Co.; Reservation Creek and Fish Creek, Apache Co. Up to 12,000 ft.

New Mexico: Stations 38, 42, 46, 50, in the Mogollon Mountains.

**Zonitoides minuscula alachuana** (Dall).

Arizona: Graham Mountain, Graham Co.; Station 6, foot of Copper King Mountain. Reservation Creek, Apache Co.

New Mexico: Big Dry Creek, Mogollon Mountains.

**Zonitoides singleyana** (Pils.).

Arizona: Station 6 (1914), foot of Copper King Mountain, 1 mile below Harper's, Graham Co.

**Euconulus fulvus** (Müll.).

Arizona: Station 58, Cosper's pasture, 59, rim of Blue Mountains, Graham Co.; Reservation Creek and Station 75, White Mountain Camp, 13,500 ft.

New Mexico: Stations 38, 42, 45, 46, 47, 50, 53, in the Mogollon Mountains.

**VITRINIDÆ.**

**Vitrina alaskana** Dall.

Arizona: Rim of Blue Mountains, 12,000 ft., Graham Co.; Reservation Creek, Apache Co., 9,000 ft.

New Mexico: Stations 45, 46, Willow Creek; Mogollon Mountains.

**VALLONIIDÆ.**

**Vallonia perspectiva** Sterki.

Arizona: Graham Mountains; Cosper's ranch of the Blue River, 5,060 ft.; Ole Hagen's ranch on Eagle Creek. Abundant.

New Mexico: Station 38, Silver Creek above Mogollon, and 57, south branch Whitewater Creek; also Big Dry Creek, Mogollon Mountains.

**Vallonia cyclophorella** Ckll.

Arizona: Cosper's pasture and rim of Blue Mountains, Graham Co.; Reservation Creek, Apache Co. 9,500 to 12,000 ft.

## FERUSSACIDÆ.

*Cochlicopa lubrica* (Müll.).

Arizona: Graham Mountain; Little Blue River; Cosper's on the Blue River; rim of Blue Mountains, Graham Co.; Fish Creek, Apache Co.

New Mexico: Stations 38, 42, 46, Mogollon Mountains.

*Pupilla blandi pithodes* Pils. & Ferr.

Arizona: Reservation Creek, and head of Black River, Apache Co.; Cosper's pasture, Graham Co. New Mexico: Stations 38, 45, 46, 47, 53 Willow Creek, Mogollon Mountains, at about 9,500–10,000 ft.

This is the same race found in great abundance along the summit of the Black Range, N. M. It is larger, especially wider, than typical *P. blandi*, the crest is weaker the striation stronger. The lip is but little thickened within, and the three teeth are well developed. It is of a walnut-brown color.

|                            |                |                  |                       |
|----------------------------|----------------|------------------|-----------------------|
| Length 3.7, diam. 1.7 mm.; | $7\frac{1}{2}$ | whorls.          | } 115,361 A. N. S. P. |
| " 3.25 "                   | 1.75 "         | $6\frac{1}{2}$ " |                       |
| " 3.05 "                   | 1.7 "          | $6\frac{1}{3}$ " |                       |

*Pupilla hebes* (Ancey).

Arizona: Cosper's pasture and rim of Blue Mountains, Stations 58, 59, Graham Co.; Reservation Creek, Apache Co. 9,500 to 12,000 feet.

*Gastrocopta ashmuni* (Sterki).

Arizona: Cosper's ranch on the Blue River, 5,060 ft., Ole Hagen's ranch, Eagle Creek. Very few found.

New Mexico: 8 Stations in the Mogollon range.

*Gastrocopta dalliana* (Sterki).

Arizona: Station 6 (1914), foot of Copper King Mountain, near Harper's place; Ole Hagen's, Eagle Creek, Graham Co.

*Gastrocopta quadridens* Pils.

New Mexico: Stations 42 and 47, Silver and Willow Creeks, Mogollon Mountains.

*Gastrocopta pilsbryana* (Sterki).

Arizona: Graham Mountains; Ole Hagen's on Eagle Creek; Cosper's ranch, Blue River; Little Blue River; Cosper's pasture; Horseshoe of Black River; Fish Creek. From about 5,000 to 11,000 ft.

New Mexico: Stations 38, 45, 47, 50, on Silver, Willow, Turkey and Big Dry Creeks, Mogollon Mountains. It is generally distributed over the wooded country covered in this report.

***Vertigo ovata* Say.**

Arizona: Station 6, foot of Copper King Mountain, 1 mile below Harper's place, Graham Co.

***Vertigo concinna* Ckll.**

New Mexico: Stations 38, 42, 45, 50, 53 (1914), on Silver, Willow and Turkey Creeks, Mogollon Mountains, Socorro Co.

***Vertigo coloradensis arizonensis* P. & V.**

Arizona: Red Sack, Graham Mountains; Horseshoe bend of Black River, Apache Co.

New Mexico: Station 38, Silver Creek, 53, Willow Creek, 50, Turkey Creek, 57, south fork Whitewater Creek, Mogollon Mountains.

***Vertigo modesta insculpta* Pils.**

Arizona: Cosper's pasture and rim of Blue Mountains; Graham Co.; Reservation Creek, White Mountains, Apache Co.

***Columella alticola* (Ingerson).**

New Mexico: Station 45, Willow Creek, Mogollon Mountains.

**SUCCINEIDÆ.*****Succinea avara* Say.**

Arizona: *Cienega* near Solomonsville, Graham Co.

New Mexico: Station 46, Willow Creek, Mogollon Mountains.

**PHYSIDÆ.*****Physa virgata* Gld.**

Arizona: Stations 19 and 20, Blue River.

***Physa* sp. undet.**

Arizona: Reservation Creek, near the Big Spring, Apache Co. With only immature specimens and broken adults an identification is difficult.

**UNIONIDÆ.*****Anodontia dejecta* Lewis.**

Arizona: Black River, southern border of Apache Co.

"Subfossil" valves of this species are found in the banks of the Santa Cruz river at Tucson.

COLLECTING STATIONS OF J. H. FERRISS IN GRAHAM, GREENLEE AND APACHE COUNTIES, ARIZONA, IN 1913.

47. Near Mud Springs, trail on summit of Big Graham Mountains.
48. Tank 10 miles south of Solomonsville (*Physa* only).
49. Swampy place 7 miles south of Solomonsville (*Physa* only).
50. Rock slide on the right side of the toll road, 6 miles south of Coronado. Peloncillo Range.
51. Eagle Creek.
52. Eagle Creek, 3 miles above the fork, east bank.

- 53-54. Eagle Creek, 5 miles above the forks.
- 55. Eagle Creek, 5 miles above the forks, west side.
- 56. Y Salt House branch (west fork) of Eagle Creek,  $\frac{1}{2}$  mile above Hot Air Salt House.
- 57. 4 miles above mouth of Y salt house branch on Hot Air trail.
- 58. Cosper's pasture, top of the Blue Mountains, 12,000 ft.
- 59. Southern rim of the Blue Mountains.
- 60. Fish Creek, beaver dam camp. Apache Co.
- 61-65. Rock slides along Fish Creek.
- 66-72. Black River, near Horseshoe bend.
- 73. Reservation Creek, 2 miles below Big Springs.
- 74. Camp 4 miles below Big Springs (*Physa* and *Pisidium*).
- 75. Head of Black River, camp 2 miles below summit of Thomas Peak (summit 13,500 ft.). White Mts., Apache Co., Ariz.
- 76-83. Black River, 2 miles above Fish Creek.
- 84. Y Salt House trail, rim of Blue Mountains, 12,000 ft.
- 85. Below the same.
- 86. Raspberry or East Eagle trail, 3 miles above Cosper's place on the Blue River.
- 87-88. Between Cosper's and the Little Blue River.
- 89. Mouth of the Little Blue River, 4,000 ft.
- 90. Spring 3 miles below mouth of Little Blue (*Physa*).
- 91. Sardine Creek 1 mile above mouth.
- 92. San Francisco River opposite Sardine Creek.
- 93. Rock slide on the east bank of San Francisco River, 3 miles below Station 92.

COLLECTING STATIONS OF J. H. FERRISS AND L. E. DANIELS IN GRAHAM AND GREENLEE COUNTIES, ARIZONA, AND SOCORRO COUNTY, NEW MEXICO, 1914.  
List compiled by Daniels.

- 4. Gila River drift at Guthrie, Arizona. (Stations on the San Francisco River.)
- 5. Ash Canyon one mile below Harper's on the "Frisco" (San Francisco) River, six miles above Clifton, Arizona.
- 6. One mile below Harper's, west side of Frisco River, foot of Copper King Mountain.
- 7, 8. Ash Canyon, above Station 5.
- 9. Branch of Ash Canyon below Station 5, one mile below Harper's.
- 10. Ash Canyon opposite Station 5, one mile below Harper's.
- 11. Top of Copper King Mountain, N. W. of Colorado Mine. 6 miles above Clifton. Elevation 4,500 ft.
- 12. Top of Copper King Mountain, west of Colorado Mine. 4,500 ft.
- 13. Slide on east bank of Frisco River, two miles above Harper's ranch and eight miles above Clifton.
- 14. Frisco River, two miles above mouth of Blue River.

(*Stations on the immediate banks of the Blue River, Greenlee Co., Arizona.*)

- 15. Four miles up from the mouth of the Blue River.
- 16. Five miles up the Blue River.
- 17, 18. Six miles up the Blue River.
- 19. Blue River at mouth of Pigeon Creek.
- 20. One mile down the Blue River from Base Line Ranger Station, east bank.
- 21. Little Blue River; same as Station 89 (1913).
- 22. "The Chimneys," three miles above Cosper's Ranch. Elevation 5,853 ft.
- 23. East side of Blue River one half mile below Grant Creek. 6000 ft.
- 24. One mile above Grant Creek, east side of Blue River.
- 25. Near Geo. Thompson's Ranch, three miles below Blue Post Office.
- 26. One mile above Blue Post Office. Elevation 6,100 ft.
- 27, 28. Near Blue Ranger Station.
- 29. One mile above Blue Ranger Station. (Twenty-one miles south of Luna, New Mexico, and 65 miles north of Clifton, Arizona.)
- 30. East side of Blue River, nearly at the top of the mountain.
- 31. Blue River south of the saw mill.

## (Stations in New Mexico.)

32. East side of Blue River, one mile north of saw mill.
33. East side of Blue River, three miles north of saw mill.
34. Mill Hollow, near top of hill, San Francisco Mountain, 8,500 ft.; about 8 miles southwest from Luna.
35. Near the Alma Wagon Road, 10 miles from Luna, in a rock slide surrounded by poplars. Crest of San Francisco Mountains.
36. Saliz Mountain, east side of Saliz Creek, 20 miles north of Alma, elevation 7,000 ft.

## (Stations in the Mogollon Range.)

List compiled by Ferriss. Approximate positions are shown in fig. 16.

- 37-41. Along Silver Creek above Mogollon City.
42. Near saw mill, head of Silver Creek.
- 43, 44. Bursam Road, between Silver and Willow Creeks.
- 45-49. Willow Creek.
50. Turkey Creek.
- 51, 52. Head of Mineral Creek.
- 53, 54. Head of Willow Creek.
55. Little Whitewater Creek.
- 56-58. South Fork of Little Whitewater.
59. Cave on Spring Creek.
- 60-80. Big Dry Creek.

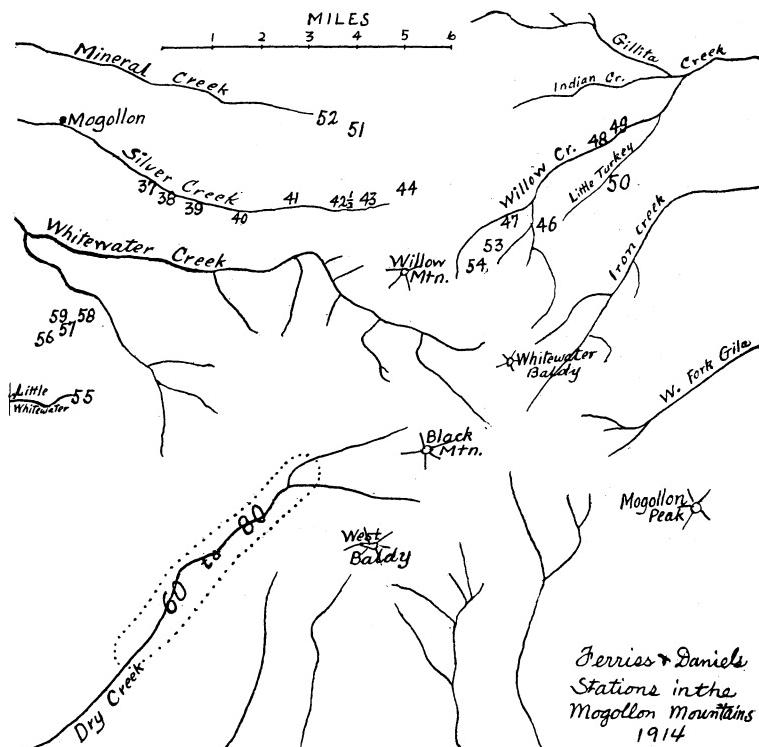


Fig. 16. Part of the Mogollon Mountains, Socorro Co., N. M. Canyons traced from U. S. Geological Survey Topographic Map, Mogollon Quadrangle, and reduced  $\frac{1}{2}$ .

## EXPLANATION OF PLATES III TO VII.

**PLATE III.**—Figs. 1a, 1b, 2.—*Sonorella odorata* n. sp. Station 18 (1917), a gulch 75 yards east of Alder Spring. No. 119,501.

Figs. 3, 3a, 3b.—*Sonorella odorata* n. sp., type. Head of Alder Canyon. No. 119,033.

Fig. 4.—*Sonorella odorata* n. sp. Form with narrow umbilicus. Station 18 (1913), Soldier Camp. No. 119,499.

Figs. 5-5b.—*Sonorella marmorarius limifontis* n. subsp., type. Station 17 (1913), bluffs near Mud Spring. No. 119,500.

Figs. 6, 6a, 6b.—*Sonorella odorata marmoris* n. subsp., type. Station 36 (1913), Old Dan Gulch, northwestern side of Marble Peak. No. 109,075.

Figs. 7, 7a.—*Sonorella marmorarius imula* n. subsp., type. Station 17 (1917), limestone hill, 6 miles northwest of Brush Corral, in the northern foothills. No. 119,503.

Figs. 8-8b.—*Sonorella marmorarius imula* n. subsp. Station 19 (1917), same limestone hill. No. 119,502.

Figs. 9-9b.—*Sonorella marmorarius* n. sp., type. Station 26 (1913), Marble Peak. No. 109,078.

**PLATE IV.**—Figs. 1-1b.—*Sonorella sabinoensis* n. sp. Half mile west of camp near mouth of Sabino canyon. No. 109,094.

Figs. 2-2b.—*Sonorella sabinoensis* n. sp., type. Station 16, mouth of Sabino Canyon. No. 109,097.

Figs. 3-3b.—*Sonorella sabinoensis* n. sp. Station 16 (1913). No. 119,487.

Figs. 4-4b.—*Sonorella sabinoensis* n. sp. Station 9, 2 miles above camp near mouth of Sabino Canyon. No. 119,488.

Figs. 5, 5a, and 5b-5d. *Sonorella sabinoensis* n. sp. Bear Canyon, Station 13 (1913). Depressed and elevated individuals. No. 119,490.

Figs. 6-6b. *Sonorella hesterna* n. sp., type. Station 148 (1917), Shaw ranch, southern foothills of the Rincons. No. 119,489.

**PLATE V.**—Figs. 1-1b.—*Sonorella sabinoensis occidentalis* n. subsp., type. Station 36 (1917), south side of Pima Canyon. No. 119,491.

Figs. 2-2b.—*Sonorella sabinoensis buehmanensis* n. subsp., type. Station 44 (1913), Buehman Canyon near Korn Kobb mine. No. 109,198.

Figs. 3-3b.—*Sonorella sabinoensis buehmanensis* n. sp. Station 43 (1913). Buehman Canyon. No. 119,492.

Figs. 4-4b.—*Sonorella tortillita* n. sp. Station 41 (1917), east side of Hog Canyon, Tortillita Mountains. No. 118,053.

Figs. 5-5b.—*Sonorella galuirensis*, n. sp. Station 30 (1917). Trail 1½ miles south of Copper Creek mining camp, Galiuro Mountains. Top and face views of type, base of a paratype. No. 119,493.

Figs. 6-6b.—*Sonorella galuirensis* n. sp. These views of a topotype. No. 119,493a.

**PLATE VI.**—Figs. 1-1b. *Sonorella cærulifluminis* n. sp., type. Station 18 (1914), west side of Blue River 6 miles above mouth. No. 119,048.

Figs. 2, 2a, 3, 3a.—*Sonorella cærulifluminis* n. sp. Station 19, Blue River at mouth of Pigeon Creek. No. 119,042.

Fig. 4.—*Sonorella cærulifluminis* n. sp. An albino specimen from the same station. No. 119,316.

Fig. 5.—*Sonorella binneyi franciscana* n. subsp., type. Station 92 (1913), east side of San Francisco River above Sardine Creek. No. 119,052.

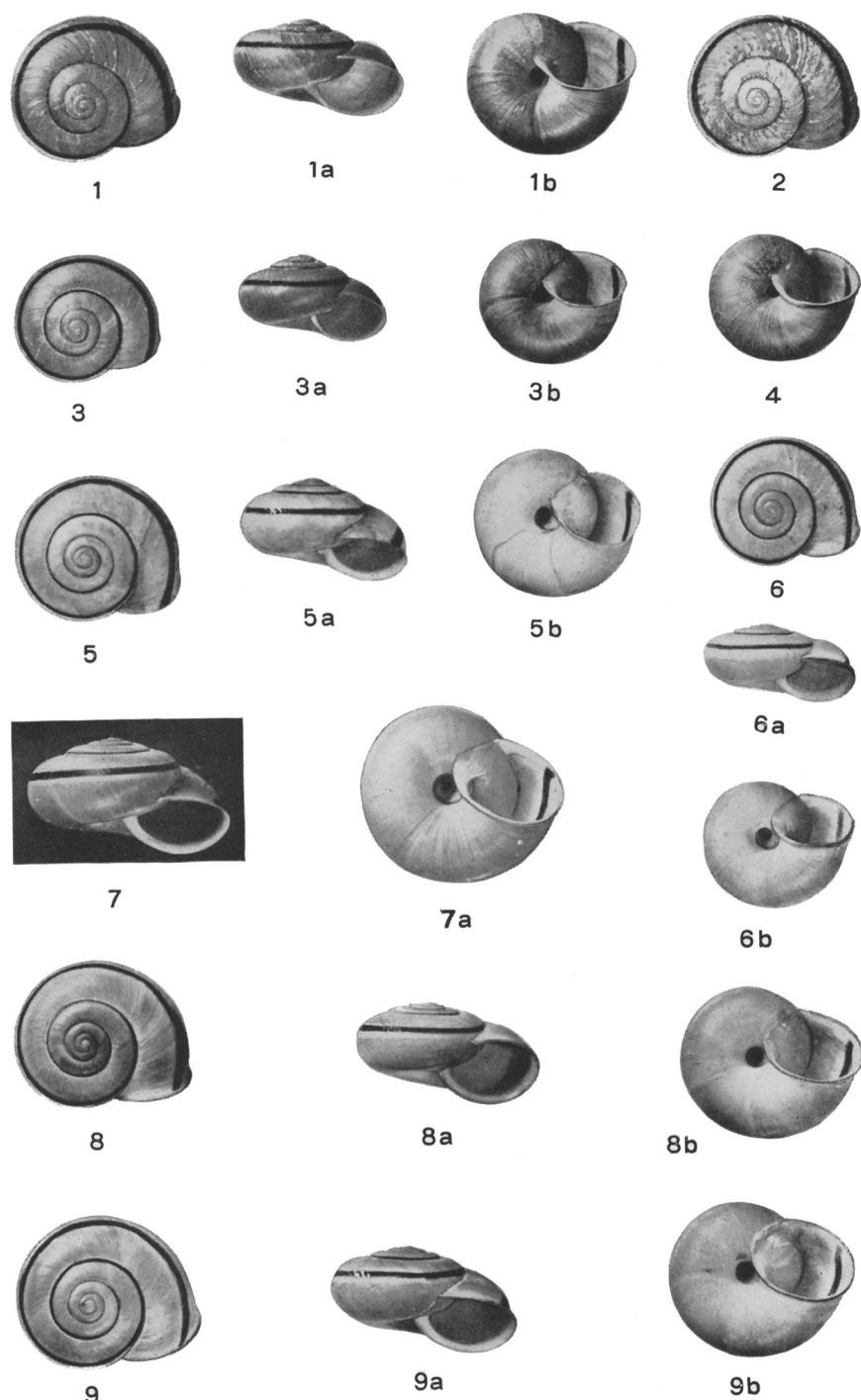
Figs. 6-6b.—*Sonorella delicata* n. sp. Type. No. 109,110.

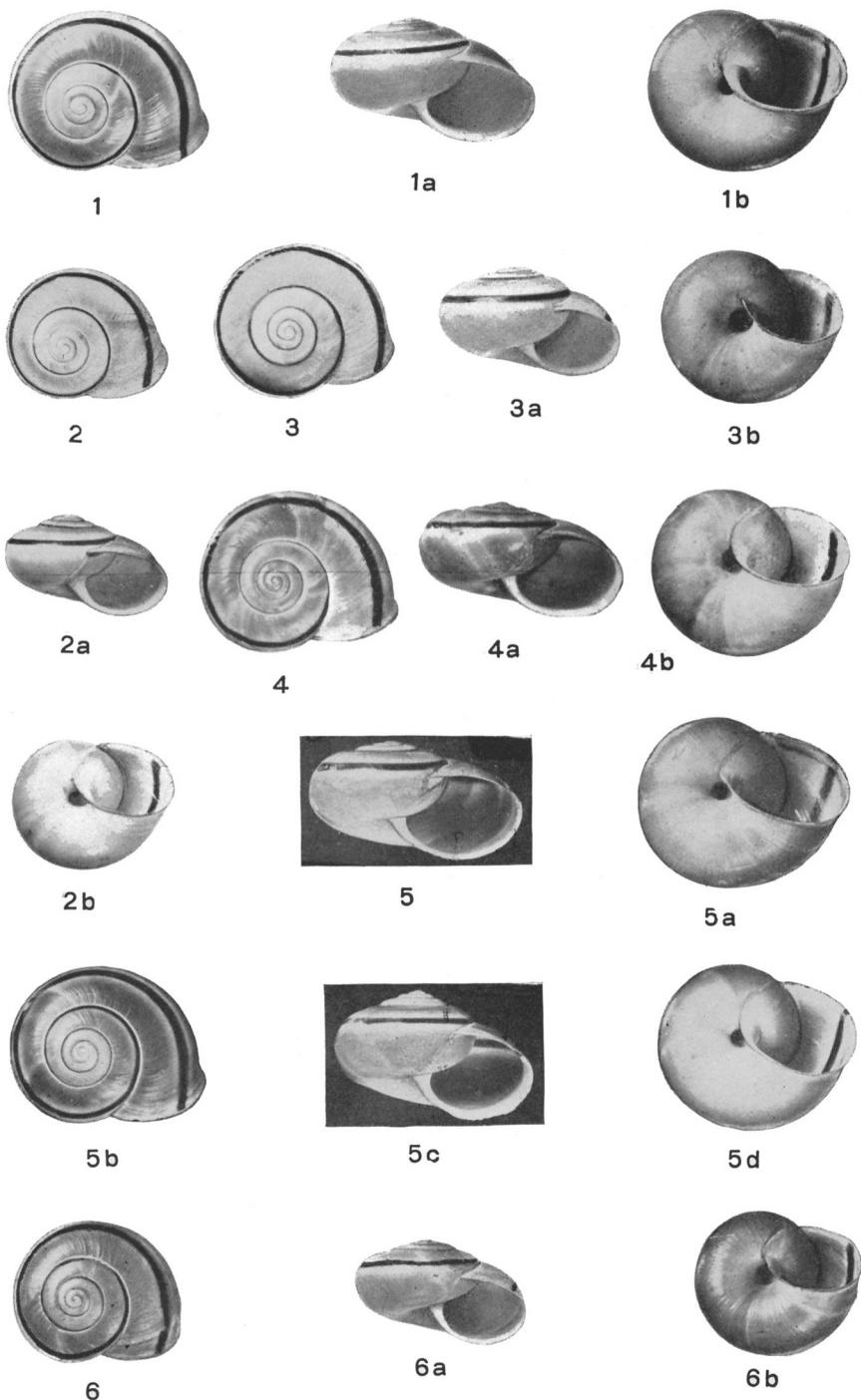
Figs. 7-7b.—*Sonorella grahamensis* n. sp. Type. No. 109,101.

Figs. 8-8b.—*Micrarionta præsidii* n. sp. Type. No. 58,121.

Figs. 9-9b.—*Sonorella rooseveliana* Berry. Type ×1.6. No. 3733 Berry collection.

- PLATE VII.—Fig. 1.—Station 58 (1913), *Oreohelix cooperi* (W. G. B.). Cosper's pasture, rim of Blue Mountains. No. 109,173.  
Figs. 2-2b.—*O. cooperi*. Station 29 (1914), west side Blue River, 1 mile above Blue River Ranger Station, Arizona. No. 119,178.  
Figs. 3, 3a.—*O. cooperi*. Station 27, near preceding station. No. 119,179.  
Fig. 4.—*O. cooperi*. Station 32, east side Blue River, N. M. No. 119,497.  
Figs. 5-5b.—*O. cooperi*. Station 23, east side Blue River. No. 2.  
Figs. 5-5b.—*O. cooperi*. Station 23, east side Blue River, 2 miles below mouth of Grant Creek, Arizona. No. 119,150.  
Figs. 6, 6a.—*O. cooperi*. Station 42½, Bursam Road, head of Silver Creek, Mogollon Mts., 8,000 ft. No. 119,498.  
Fig. 7.—*O. cooperi apache* n. subsp., type. Station 76 (1913), Black River, 2 miles above Fish Creek. No. 109,184.  
Figs. 8, 8a.—*O. cooperi apache*. Station 53 (1914). Black River. No. 109,183.  
Fig. 9.—*Oreohelix strigosa meridionalis* n. subsp., type. Y Salt House Fork of Eagle Creek. No. 109,186.







1



1b



1a



2



2b



2a



3



3a.



3b



4



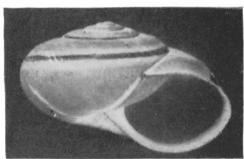
4a



4b



5



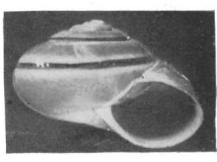
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6



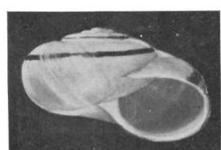
6a



6b



1



1a



1b



2



2a



3



3a



4



5



5a



5b



6



6a



6b



8



8a



7



7a



7b



8b



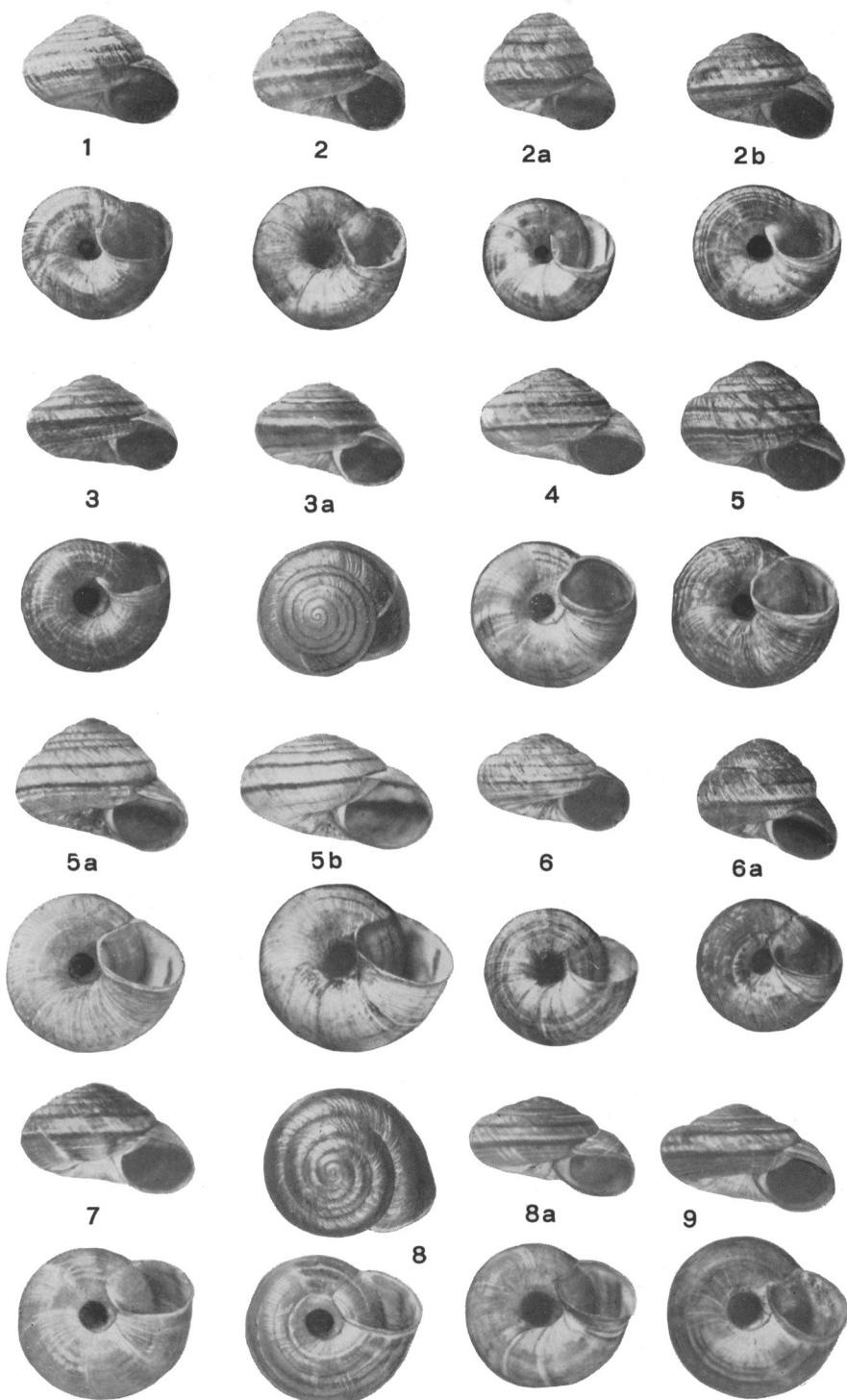
9



9a



9b



PILSBRY AND FERRISS: SOUTHWESTERN MOLLUSCA.